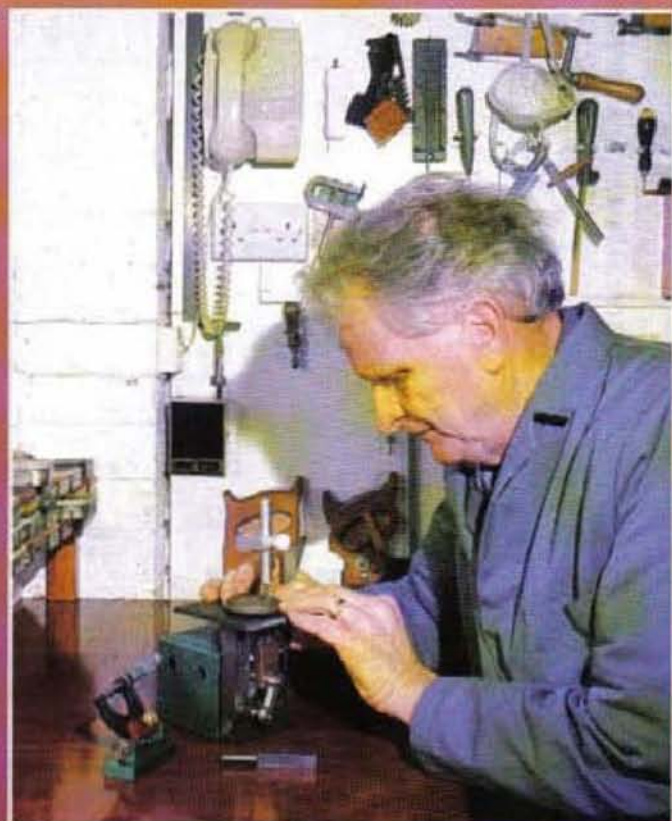
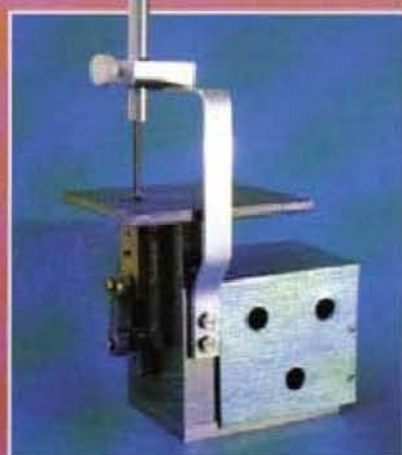


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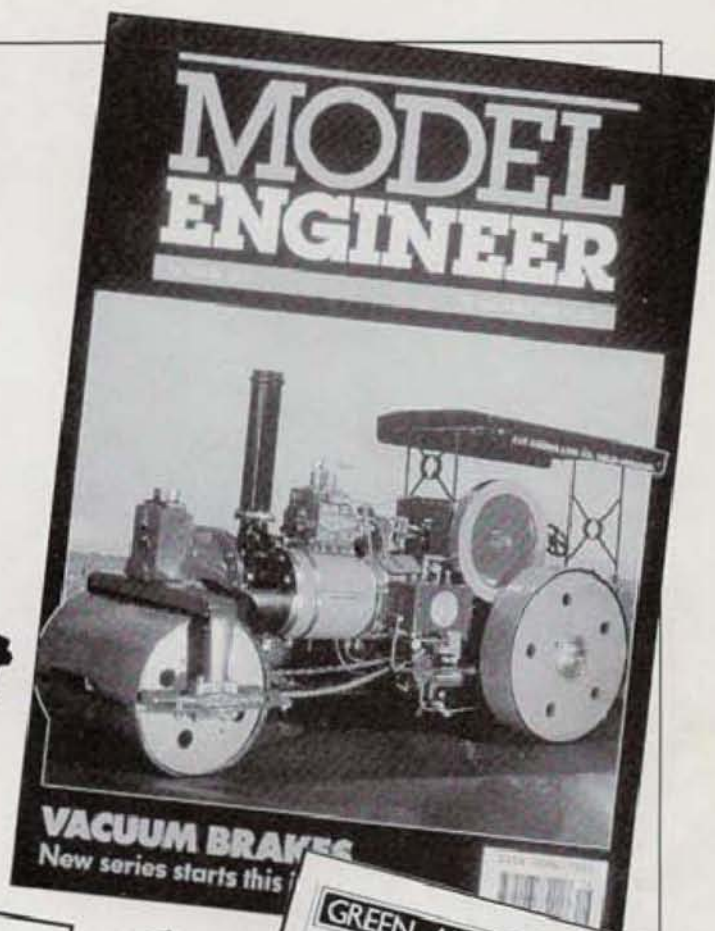
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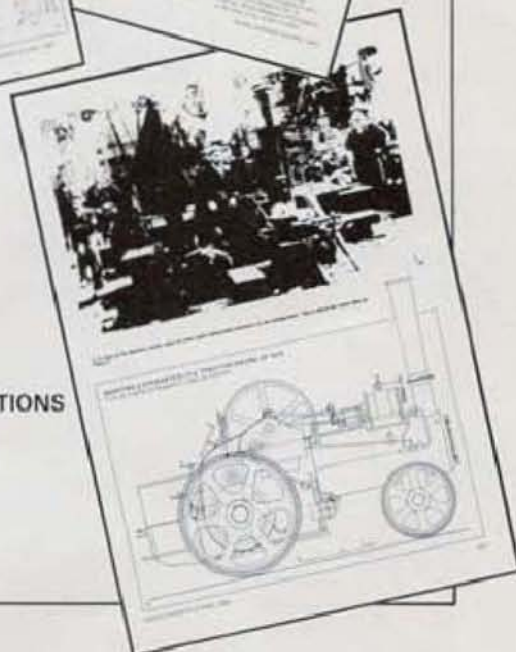
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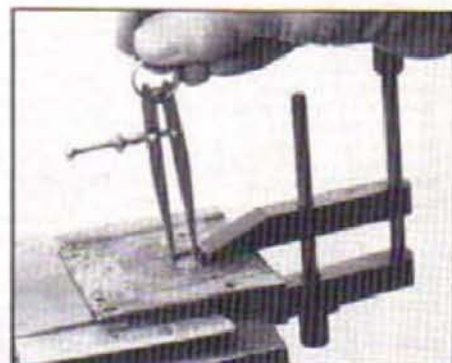
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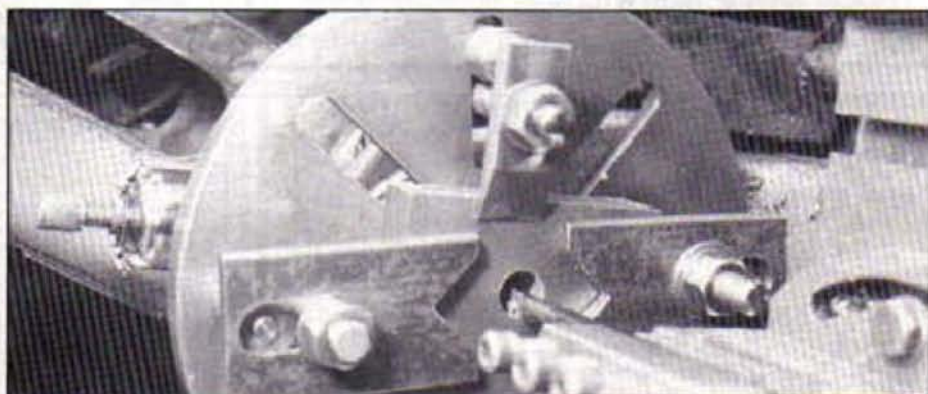
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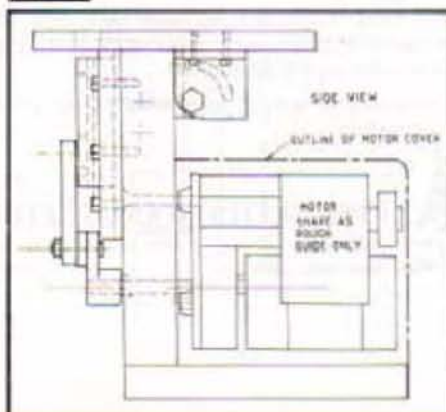
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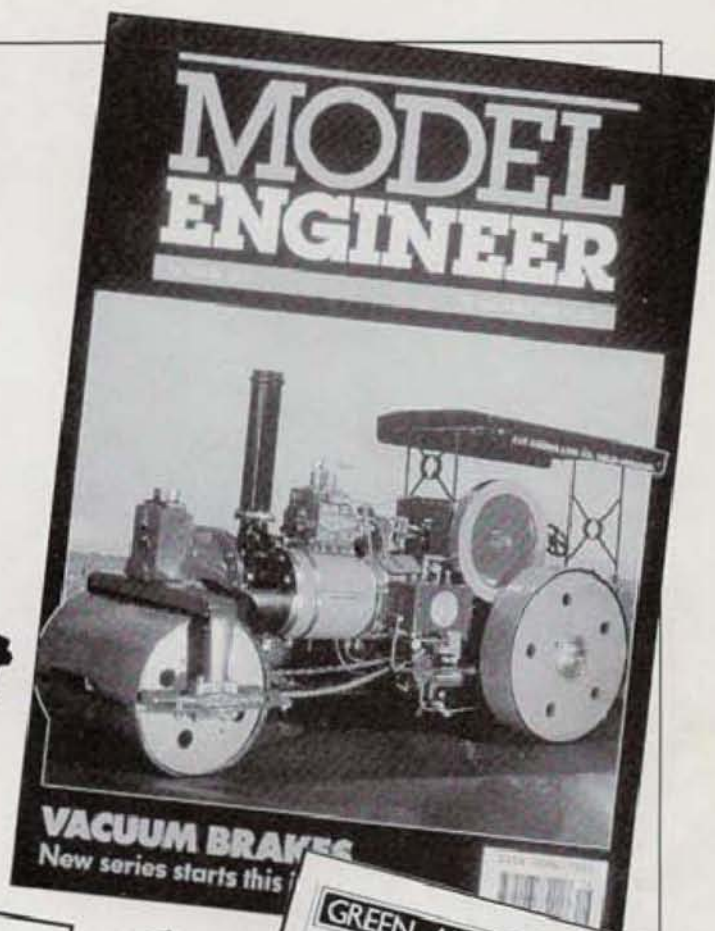
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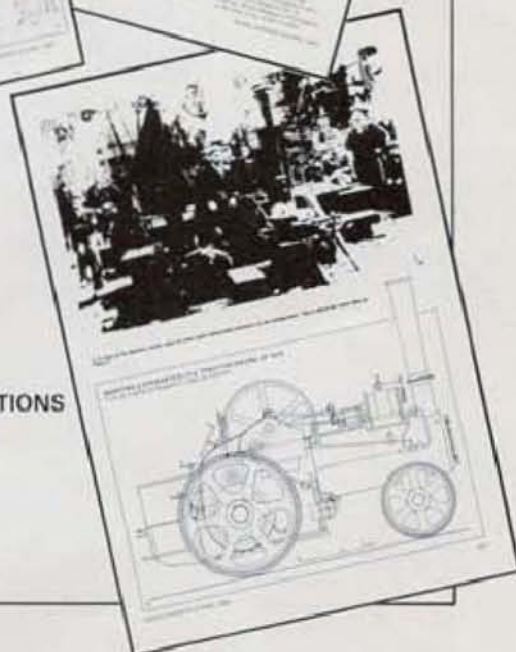
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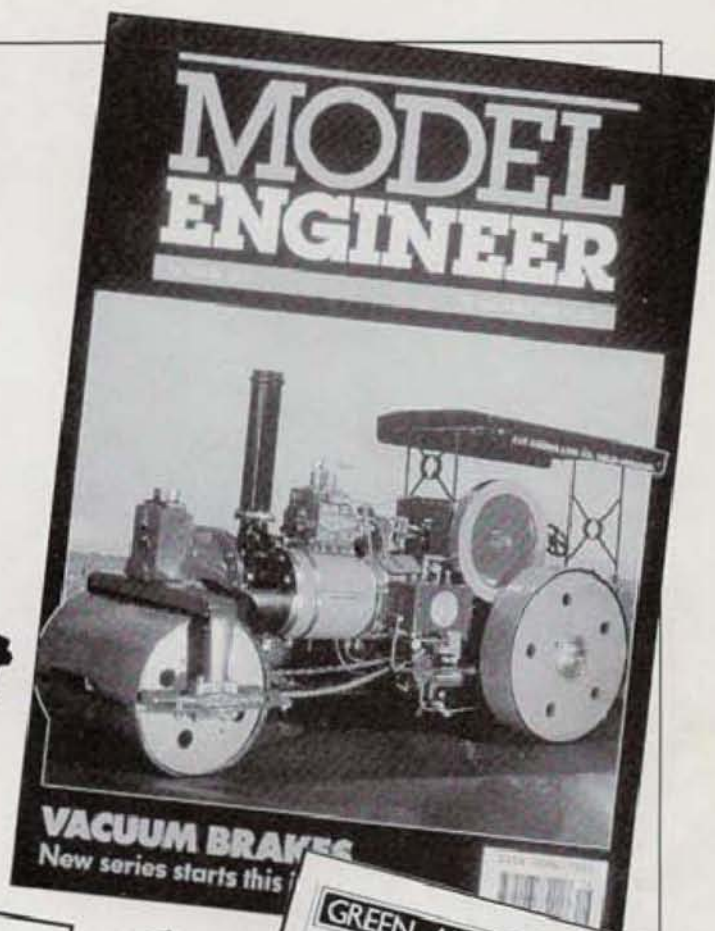
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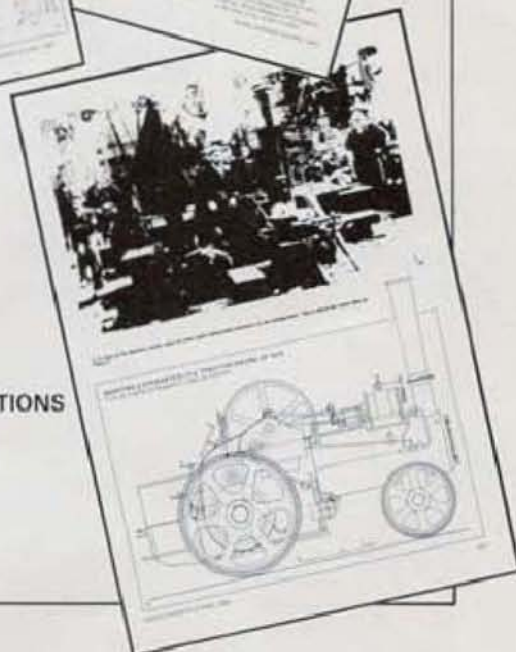
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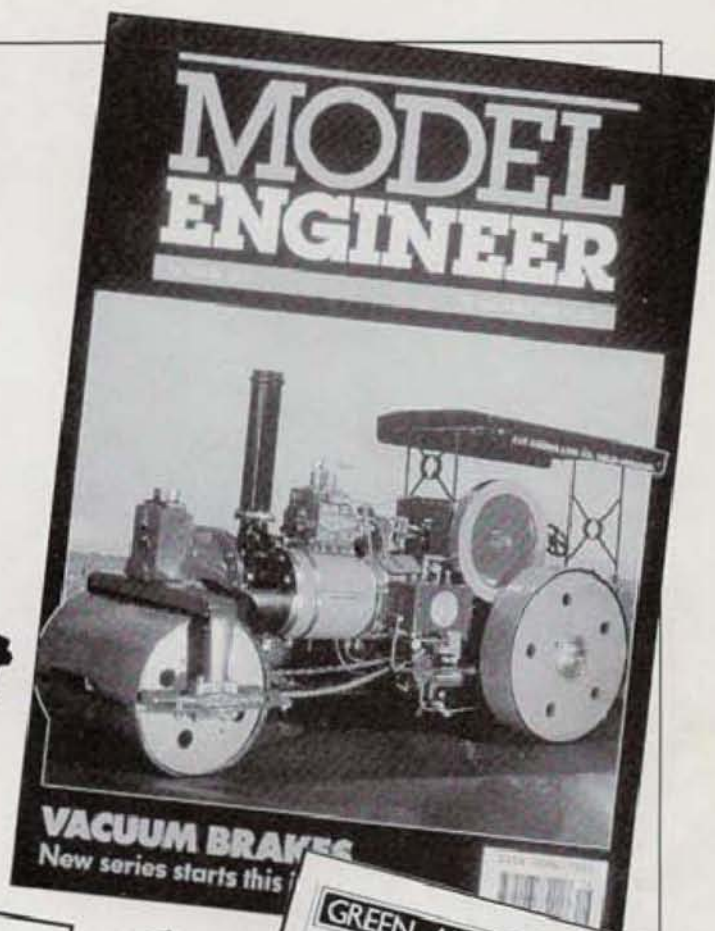
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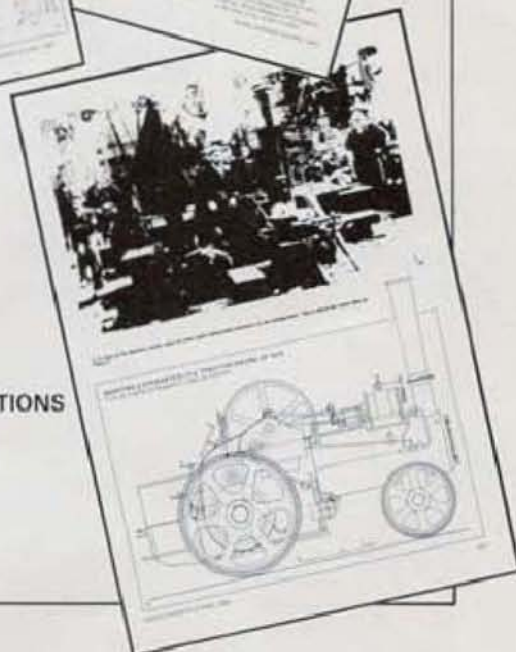
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Stuart Gray

ON THE EDITOR'S BENCH

This April/May issue of *Model Engineers' Workshop* sees the end of the first year of publication. Well almost, anyway. In fact it will be on sale just a few weeks earlier than expected because of the change over to bi-monthly publication. It has without doubt been a huge success and the demand has been difficult to cope with. In particular there have been so many requests for issue number one that, as a result, Argus Specialist Publications have arranged for it to be reprinted! There will be five thousand copies available, and they can only be obtained direct from ASP at our Hemel Hempstead address. The price, including postage and packing is £3.10. They will be sold on a first come, first served basis, so hurry if you missed our launch issue!

This is the first issue since the Model Engineer Exhibition at Alexandra Palace. Many readers came up and introduced themselves there and I was pleased to meet them and get their views on how things are going. There was plenty to see at the Exhibition and, in particular, more than the usual number of demonstrations of workshop practices, with not only the Society of Model and Experimental Engineers having their regular workshop, but also some of the clubs going to a lot of trouble to organise workshops on their stands. There were, of course, many cheap tools and a great deal of machinery available for sale, as well as examples of workmanship of high quality.

In this issue the accent has been, to a large extent, on marking-out practices and marking-out tools. I hope readers will all find something to interest them. There are, of course, articles that are not related to the subject and, in particular, we are presenting another 'first' with part one of a two-part article on a superb geometric chuck.

I am very grateful to all those readers who have written encouraging letters, as well as those who have sent in ideas, and indeed not least to those with constructive criticism. Only through being criticised in a constructive way can the standard of the

magazine be maintained. As far as practical I have tried to reply to all letters, although there has been a time-lag due to the large number received. I hope to have finished all the replies by the time this magazine is printed.

The fact that the magazine is now to be a bi-monthly publication is going to have two effects. Firstly, there will be a need to engage someone to assist with editing it. This will be a freelance post, with the person concerned working from home on a part-time basis. The position is one which would suit someone with a wide knowledge of workshop and engineering practices, and who is looking for the chance to supplement their income. It will ideally suit someone who has taken early retirement, and it is an excellent opportunity for such a person to become involved in the publishing of a very rapidly growing magazine. The work will involve workshop activities, writing, drawing and photography. If any reader is interested, will they please write to Alec Gee, Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead, Herts HP2 7ST.

Also, as the magazine is to be published on a bi-monthly basis, regretfully I shall be taking a much less active part in things. I am no spring chicken, to say the least, and feel I cannot cope with the extra work that will be involved, particularly as I live rather a long way from Hemel Hempstead, and extra visits to Argus Publications would be required. I would like to thank the contributors and readers for the support they have given me and for the very kind comments I have received. I shall be following events closely and watching what, I hope, will be further considerable success of a very good magazine.

And lastly - we omitted to name the writer of the fascinating 'Talk about Flea Power' article in the last issue. It was the work of Brian Taylor - to whom many thanks and our apologies for not saying so in the first place!

IN OUR NEXT ISSUE!



There's another feast of useful tools, ideas, advice and projects for you to enjoy in the next issue of MEW! They include:
A CLUTCH FOR THE LATHE - Our full-size FREE drawings
A USEFUL CROSS DRILLING DEVICE



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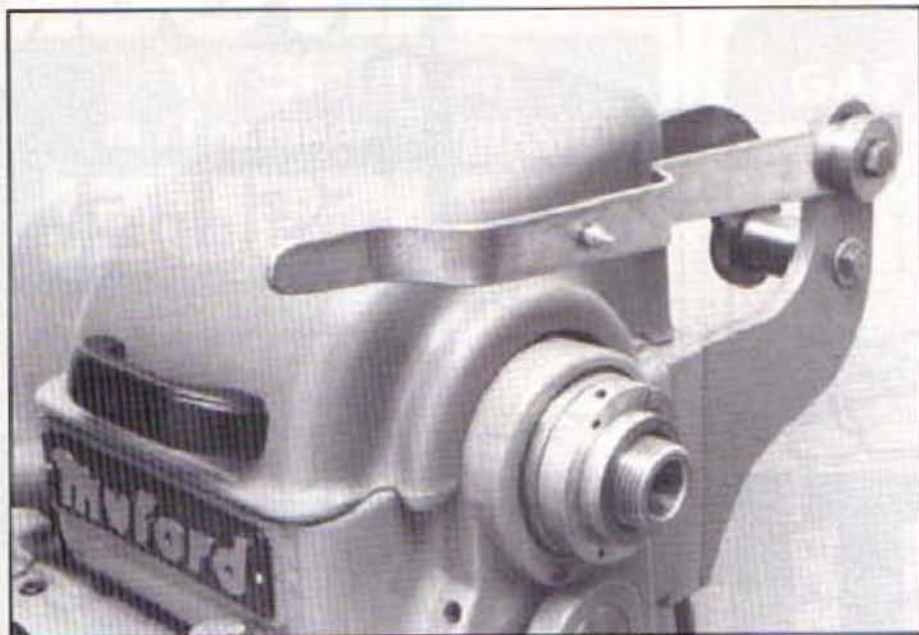


Photo 1. The latching arm and bracket on a modified Myford Super-7.

DIVIDING ON YOUR LATHE

This article, by our old friend Ted McDuffie from the U.S.A., explains easy ways of dividing in the lathe. Ted has his own particular set-up for milling and drilling, but an ordinary toolpost drilling/grinding attachment will do the job – although probably not quite as well as his masterly arrangement! We are sure that readers will be delighted with the article

Your needs for dividing may be as simple as locating set screws or filing a square, or more complicated like gear cutting or complex angular layouts. By using the jaws of a three- and four-jaw chuck for dividing, it is possible to provide reasonably accurate two, three and four division operations. Using the chucks for dividing also makes it apparent that this is a very useful provision and that there is a need for a more permanent and accurate set-up on your lathe. With dividing provisions on the lathe, accuracy is improved by being able to determine division locations before the workpiece is removed from centre. Procedures outlined in this article are directed primarily to the Myford Super-7 but are applicable to lathes in general.

Probably the most basic need in dividing is finding two points that are exactly 180 degrees apart. With proper dividing equipment, any number of positions may be determined on a round or flat surface of a workpiece set up in a lathe. Many complex layouts become simple when the operation is carried out while the workpiece is on lathe centre.

There are two general methods of dividing on a lathe: with the dividing attachment on the cross slide or with the dividing provision on the headstock. The

primary advantage of dividing on the cross slide is the fact that the headstock may be used for powering cutting tools. The problem with this arrangement is that the usual top speed of the lathe headstock spindle is far below the proper rotational speed of a small drill or milling cutter. Also, special equipment is required to mount work on the cross slide. With dividing on the headstock, the headstock provides a solid workbase with a variety of mounting devices such as collets, chucks and face plates. Turning speeds of 5,000 revolutions per minute and over are easily attainable with milling attachments. After work has been turned in, the lathe positions may be marked and, if equipment permits, it may be drilled or milled.

Dividing or indexing may be grouped into two general classes: direct or geared. Direct indexing determines divisions directly from a plate or other dividing standard. Geared dividing utilizes a wormdriven gear with the index plate used to position the worm. My personal preference is direct indexing, because work can be quickly and accurately moved to any position. My geared dividing equipment ranges in size from a large Brown & Sharpe dividing head to a Myford dividing attachment, but I use this equipment primarily for making dividing plates.

Although I have added dividing capabilities to my chucks, faceplates and headstock spindle, the most useful holding device is the chuck. The usual division for chucks and faceplates is 24 holes and this places the division holes at 15 degree intervals. With 24 holes, divisions of 2, 3, 4, 6, 8, 12 and 24 are available and simple angular work is possible. It is advisable to leave space on your dividing plates for extra divisions that might be required in the future. As I use divisions of 3 and 4 frequently, I have separate rows of holes on my chucks for these two divisions. As an alternative, the 3 and 4 division holes of the 24 holes, may be colour coded or numbered.

There is almost no limit to the specific uses of dividing equipment. In my restoration work I frequently need to make calibrated dials. On my three-jaw chuck I have provided an outer ring of a hundred holes. With this, and a suitable grooving tool in the toolholder, it is a simple matter to lay out dial divisions. A faceplate with three hundred and sixty divisions serves as a dividing table for intricate layout work such as wheel spokes and complex angular work.

Latching arm

The latching arm should be stiff enough to prevent movement of the headstock spindle. Lathes with large bronze bushings require considerable effort to move the spindle from a stationary position so they must be equipped with a very rigid latching arm. I have used $\frac{1}{2} \times 1$ in. cold rolled steel for the arm on my Myford Super-7, but hard brass is satisfactory. A slot should be provided on the mounting end in order to be able to position the arm to a preset location of the dividing plate. All of my dividing devices use the same latching arm, but I use different pins to match the holes in the plates. As an example, I use .040 in. holes on a 10 in. plate with three hundred and sixty divisions and .080 in. holes on a 6 in. plate with 24 holes. It is necessary to use smaller holes with higher counts to provide space between the holes. These $\frac{1}{8}$ in. pins are threaded into the arm and locked with a locknut as in Photograph 1.

The latching arm may be mounted on the stationary section of the motorizing unit of a Myford Super-7. A $\frac{1}{2}$ in. thick reinforcing pad should be fastened to the inside of the motorizing shell and tapped for the mounting bolt. Be certain that the mounting bolt cannot interfere with the belting. The latching arm can be helpful in drilling or marking the plate for divisions, so it is advisable to install it first. My Myford Super-7 is equipped with a direct drive motor for powering the headstock or accessories on the cross slide. The latching arm and the mounting bracket are shown in Photograph 1.

If it is necessary to install a bracket for mounting the latching arm, be certain that it is attached to the headstock or lathe bed and is perfectly rigid. Most lathes have accessory holes that can be used for mounting the arm bracket or have bolts in use that can be extended to accommodate the bracket.

Dividing plate

Brass makes an excellent dividing plate, but steel or other metals will be satisfactory.



Photo 2. Turning the inside of the dividing ring to fit the six-inch chuck.



Photo 3. Heating the dividing ring on the ring of an electric cooker.

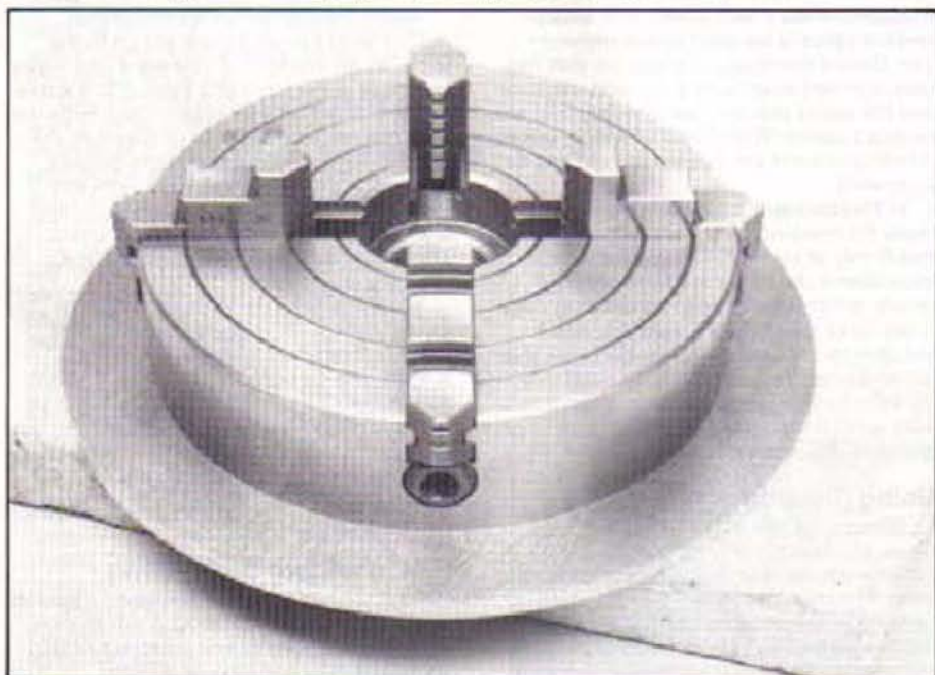


Photo 4. Positioning the six-inch chuck inside the heated brass ring.

For mounting on a chuck, use $\frac{1}{2}$ in. thick plate stock. Saw the plate to approximate size, mount on a mandrel and turn the outside to the proper diameter.

Photograph 2 shows the 8 inch plate being turned to fit the body of the chuck after the outside has been turned to size.

After trying various methods of attaching a dividing ring to a chuck, I find that heating the brass ring to expand it, is the preferred method. If the brass ring is cut 10 to 15 thousandths of an in. undersize, heated to about 180 degrees F. to expand, and then mounted on the chuck, it is very rigid. For a steel dividing ring, 5 thousandths of an inch undersize is sufficient. **Photograph 3** shows the dividing ring being heated on a stove burner and **Photograph 4** shows the chuck seated in the dividing ring. The dividing ring is 1 in. wide and will accommodate four to five rows of division holes.

Most faceplates have a flat machined outer ring on the backside that is satisfactory for drilling for dividing. Faceplates can usually be mounted on the headstock backward and the holes may be marked or drilled similar to the method used for chucks. If more divisions are required, a brass ring may be attached to the back of the faceplate with screws.

The Myford Super-7 has space between the shoulder on the spindle nose and the collet nosepiece to mount a brass collar to accommodate a $\frac{1}{2}$ in. thick dividing plate. For cutting small gears and holding small workpieces for dividing this is a very practical set up. A brass hub is fitted to the spindle, locked in place with a locking bolt and cut to receive the plates. The dividing plates have $1\frac{1}{2}$ in. centre holes and have three mounting screws. Plates of $\frac{1}{4}$ in. thickness can be drilled for divisions on both sides and a 10 inch plate can accommodate 30 circles of dividing holes. In **Photograph 1** the dividing plate adapter is in place and provides adequate clearance for the Myford nosepiece.

Drilling the plate

Most of us have a friend or acquaintance who has some means of dividing. If a dividing plate is available with the proper divisions, it is often possible to epoxy the plate to the face of your chuck. The chuck can be mounted backward on the headstock or on a piece of round stock mounted in a collet or another chuck. The latching arm may be mounted to engage the dividing plate with a longer mounting bolt and a number of washers. This will position the dividing ring to be marked or drilled toward the top slide. Be certain to have the dividing standard and the plate to be drilled on dead centre or errors in spacing of the holes will result.

Just how the actual drilling of the division holes is accomplished depends upon the equipment available. With a dividing head it might be advisable to mark or drill the divisions before the centre section is cut out of the dividing ring. If you are set up to drill with the drill mounted on the cross slide, the dividing holes are drilled as the plate is positioned for the divisions. Use a centre drill and drill the holes about

$\frac{1}{8}$ in. deep. A centre punch or scribe mounted on the toolpost will provide marks to locate holes for drilling on a drill press. Extreme care should be exercised to

maintain accuracy when using a drill press to drill the holes. Make the centre punch depressions deep and be sure that your centre drill is sharp and is ground with the tip on dead centre.

When one of your chucks or faceplates is drilled for 24 divisions, it is a simple matter to transfer these divisions to other chucks or faceplates. A few dots of epoxy will hold a faceplate or chuck to another faceplate or chuck for marking or drilling. Remove the jaws from the chuck to provide a larger flat surface. I have found that three small dots of 5 minute epoxy are sufficient and the parts can be separated by a sharp blow with a rubber hammer.

Dividing with a tape

Even without dividing equipment it is a rather simple matter to divide the ring. Early clockmakers found it easier to divide a strip of brass into equal divisions than to accurately divide a circle into equal divisions. The steel tape elements in tape rules are accurate enough for most dividing applications. If you have an old or damaged tape rule, the high number end will usually be in good condition. Replacement tapes are available for most quality tape rules and are relatively inexpensive.

First select a number that will divide into the number of divisions that you require and will also form the circumference of a circle of usable size. As an example, we will select 24 inches as this will give us 24, 1 in. divisions and form a circle of 7.639 in. in diameter. Had we wanted an unusual division such as 51 we could have selected 25.5 in. and used $\frac{1}{2}$ in. divisions. I use a small brass sleeve to join the ends and I cut the ends at an angle. Notice the brass sleeve on the measuring tape just below the plexiglass in **Photograph 5**. With the ends cut at an angle, it is easy to determine when the division marks on the tape ends are exactly in line with each other. I use 5 minute epoxy resin to hold the ends in the sleeve at the proper position.

After the 24 inch tape band is completed, turn a disk out of composition board or wood to exactly fit inside the band. File a small depression in the disk to accommodate the extra thickness of the brass sleeve and attach the tape with epoxy. **Photograph 6** shows the wood disk with the tape installed and a recess cut on the inside to fit tightly on the outside of the chuck. You will notice that many other divisions are available with this disk by using smaller division marks on the scale. It is possible to provide the divisions for cutting the gears for a complete clock with a 30 in. circumference plate. Many clock gear trains may be duplicated with the divisions obtained from two plates. By fitting the disk to the outer end of the headstock spindle and using a large diameter disk, accurate divisions of any number may be transferred to a plate set up in the lathe.

When the wood disk is completed it is epoxied to the chuck and set up in the lathe. The 6 inch 4 jaw Burnerd chuck will mount on the Super-7 backward, if the jaws are removed. A $\frac{1}{2}$ in. thick washer on the spindle is required to prevent the wood disk from touching the backgear lever. **Photograph 7** shows the chuck mounted with the dividing ring and the wood disk. The latching arm can be used with the disk with the addition of a small indicator and a

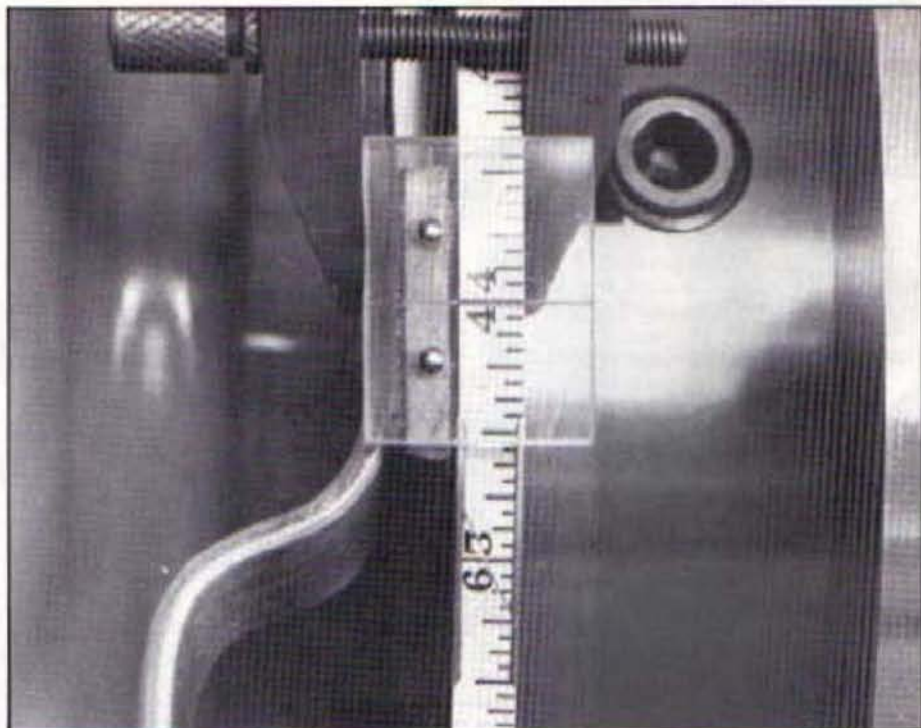


Photo 5. The perspex (or plexiglass) indicator epoxied to the latching arm.

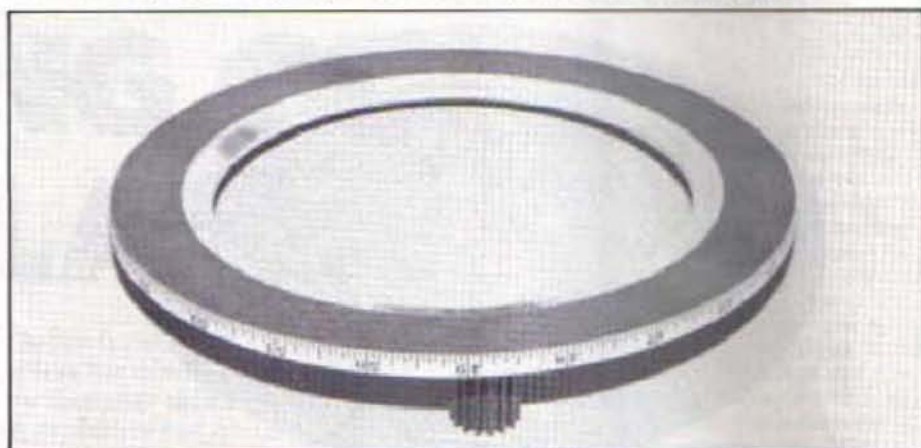


Photo 6. The wooden ring, complete with tape, is grooved to accept the chuck.

clamping device. **Photograph 5** shows the plexiglass with the indicator line cut on the underside. The plexiglass is secured to a small wood block with brads and epoxy and the block is epoxied to the latching arm. Before continuing, be certain that the tape is joined exactly on a division mark and the wood disk and the dividing ring are on exact centre. With direct indexing, errors in hole positions are transferred directly to your work.

In **Photograph 7** the dividing ring is ready for marking or drilling. Clamp the disk firmly at each position with a small toolmaker's clamp, as in **Photograph 7**, before drilling or marking the dividing ring. A set up of this type is a very practical solution for odd dividing requirements that are occasionally needed. I have used this method for cutting unusual clock wheels with special tooth counts and special splines with unusual divisions.

Using dividing equipment

When your dividing mechanism is in place, the next need is for a device to transfer the division to the workpiece in the lathe. The sharp edge of a cutting tool may be used or a special scribe that fits the toolpost is well worth the effort necessary to make it. I find that a 60 degree, $\frac{1}{2}$ in. hard centre mounted in a $\frac{1}{2}$ in. boring tool holder is very satisfactory. The tip of the centre is

on lathe vertical center. It is suitable for scribing lines and circles or making punchmarks.

Many layouts can be accomplished quickly with the workpiece set up in the lathe. As an example, if you want four holes in a plate in the form of a square, it is easily accomplished on a faceplate. Determine the dimensions geometrically or measure the distance between opposite hole centres and scribe a circle on the work with this diameter. Engage the dividing attachment and scribe four marks 90 degrees apart. The lathe centre will also mark the exact centre of this square.

For those who do intricate milling or layout work, a faceplate drilled with 360 holes makes an excellent rotary table. Angles may be accurately scribed on work, and measurements of scribed lines can be read from the cross slide dial. For laying out spokes in a wheel or gear, the layout holes on the plate may be marked with a felt pen to make duplication of subsequent wheels or gears a simple matter.

Use in milling and drilling

To this point we have discussed marking work for milling and drilling. A whole new world of versatility opens when you equip your lathe with a milling or drilling attachment mounted on a vertical slide on the cross slide. All sorts of complex milling

and drilling operations may be accomplished with this arrangement. The milling attachment in **Photograph 7** uses Myford collets and will accept cutters and end mills up to $\frac{1}{2}$ in. shank diameter. If accessories are difficult to mount, they are seldom used. I use "T" bars rather than "T" bolts to mount my vertical slide and milling attachment. Two bolts are threaded into each bar and the accessory may be removed by loosening each bolt about one turn. To stiffen my Myford vertical slide I have added a third $\frac{1}{2}$ in. bolt to the slide and attached the slide to a four bolt mounting pad.

The selection of milling and drilling devices for mounting on vertical slides is almost limitless. If you prefer, you can make a milling attachment with your lathe. The milling attachment in **Photograph 7** can be made on a Myford Super-7 equipped with a vertical slide. Also I have seen some excellent results with heavy-duty grinding attachments, used with speed controls, for milling and drilling. At the other extreme I have seen small $\frac{1}{2}$ in. capacity grinders, mounted on vertical slides, that produced acceptable results with small workpieces.

The first problem with milling attachments is providing power. I have solved this problem on my Myford Super-7 by mounting the motor on a slide and using it as power for the headstock and the attachments. With a six pole motor and a three step pulley the speed range of the standard Super-7 has been extended. The drive is direct from motor to headstock with $\frac{1}{2}$ in. round leather belting. By using a motor with pulleys on each end, the headstock and the accessories may be driven at the same time for special grinding and milling applications. With a stanchion on the motor base and overhead idler pulleys the milling head can be powered in any position. My modified Super-7 may be seen in **Photograph 8**.

For cutting gears I use a dividing plate mounted on the nose of the Myford Super-7 headstock spindle, just behind the nose piece. The gear blanks may be turned to size and the teeth cut without removing the blank from the headstock. I consider the dividing plate superior to the geared dividing head for cutting gears because any space on the gear is immediately available for measuring or altering.

Small splines and slots are easily cut with a single point tool mounted on the cross slide. For heavier work a milling attachment is very helpful and slots or grooves may be cut with a saw, and an end mill, a key way cutter or a fly-cutter.

Cutting threads up to a large shoulder without a groove at the end of the thread can present a problem on a small lathe. Most of us have accomplished this with a crank on the lathe spindle and have found it to be very time consuming. With milling on the cross slide, difficult threading projects become very simple. The lathe is set up for thread cutting and the spindle is hand turned until the thread is cut to the proper length. A formed fly-cutter will provide excellent threads in materials that range in hardness from silver steel to softwood or plastic. Threads may be cut full depth in one pass.

Milling can be dangerous if proper precautions are not observed. Cutting tools can break and belts and pulleys can become entangled in clothing. When using fly-cutters always provide a safety shield of

plexiglass between you and the cutter. At the higher rotating speeds of small cutters very little power is required and small plastic belts are very satisfactory. I do almost all my milling on the lathe with a round $\frac{1}{2}$ in. plastic belt. For heavy milling I use $\frac{1}{2}$ in. round leather belting and this is always used at lower speeds. If you provide power for your milling head with a separate motor, use a fractional horsepower motor as they are much less dangerous. I have a gear cutting machine for brass clock wheels and steel pinions that is powered with a $\frac{1}{2}$ horsepower motor. A capacitor start motor of $\frac{1}{2}$ horsepower is more than adequate for any small milling attachment on a small lathe. I prefer synchronous motors for driving cutting tools as they provide more accurate cutting speed control. Cutting speeds are very critical when using light milling equipment and must be observed when milling on a lathe.

Conclusion

Once your lathe is equipped for dividing you will find that more of a job can be completed before you remove the work from the lathe. With the addition of milling on the cross slide your lathe becomes a virtual workshop. In my shop I have vertical and horizontal milling machines but for small workpieces I find it easier and more accurate to make milling cuts before I remove the work from the lathe centre. With the ability to position the work at various positions, removing equal amounts of metal from these positions on the work becomes a simple matter. After you complete your original addition of the latching arm and a dividing plate it is rather simple to add more dividing plates. You will find that every addition to your lathe's capabilities opens new possibilities to you and the pleasure you get from your tools. **GOOD LUCK!**

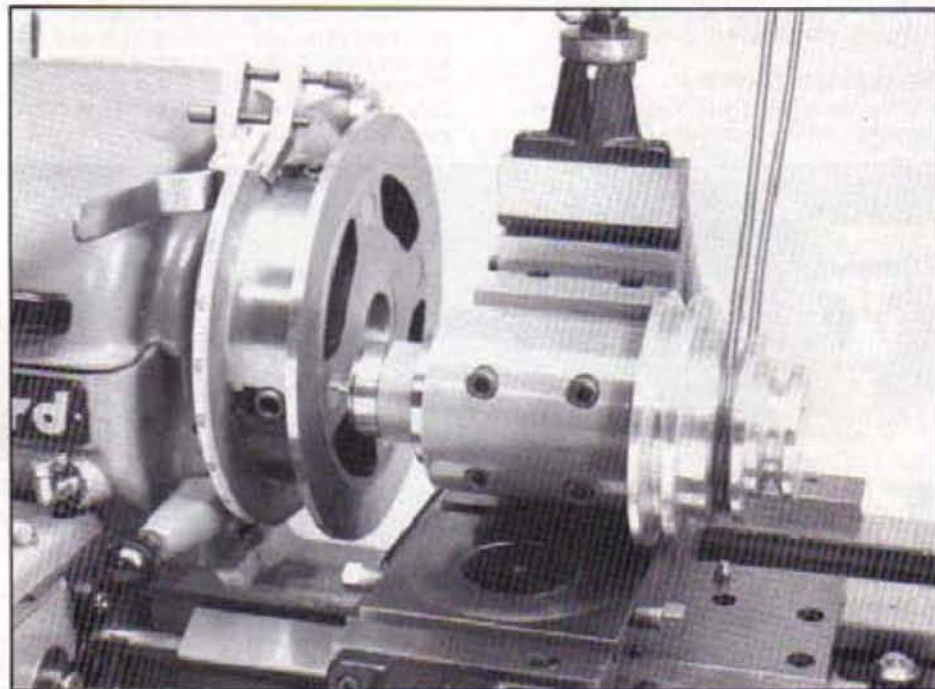


Photo 7 This illustration shows the set-up for marking or drilling dividing holes.



Photo 8 The author's modified Myford Super-7 lathe with the stanchion in place.

The newcomer to the hobby is all too often disappointed upon receiving that nice brand new lathe, to find that it arrives without a chuck. At one time chucks were *never* supplied with lathes; fortunately these days suppliers are somewhat enlightened and will frequently supply the chuck at the same time. This is not always so and sometimes, even when a chuck is supplied, it will need to be fitted. The fitting involves machining a suitable backplate to hold the chuck to the particular type of lathe. There are so many types that it is not practical for chuck manufacturers to supply suitable fittings except for particular models.

The first job, then, for our would-be home machinist may well be the fitting of the backplate in order to mount the chuck. To many a beginner this is a most frightening proposition. After all, the accuracy of the chuck and therefore to a large extent the lathe, will depend on how well the backplate is fitted. It is not really so difficult if taken step by step, and here it is hoped to allay some of those fears.

Backplate castings

The backplate is a casting, rather like a faceplate, without the slots. Fortunately, it is

Lathe chucks are, more often than not, fitted to the lathe via a backplate which has to be machined to fit both the lathe and the chuck. At first sight, particularly to the inexperienced, this seems a rather frightening job. With care it is not so difficult as it sounds, and in this article we explain how it can be done

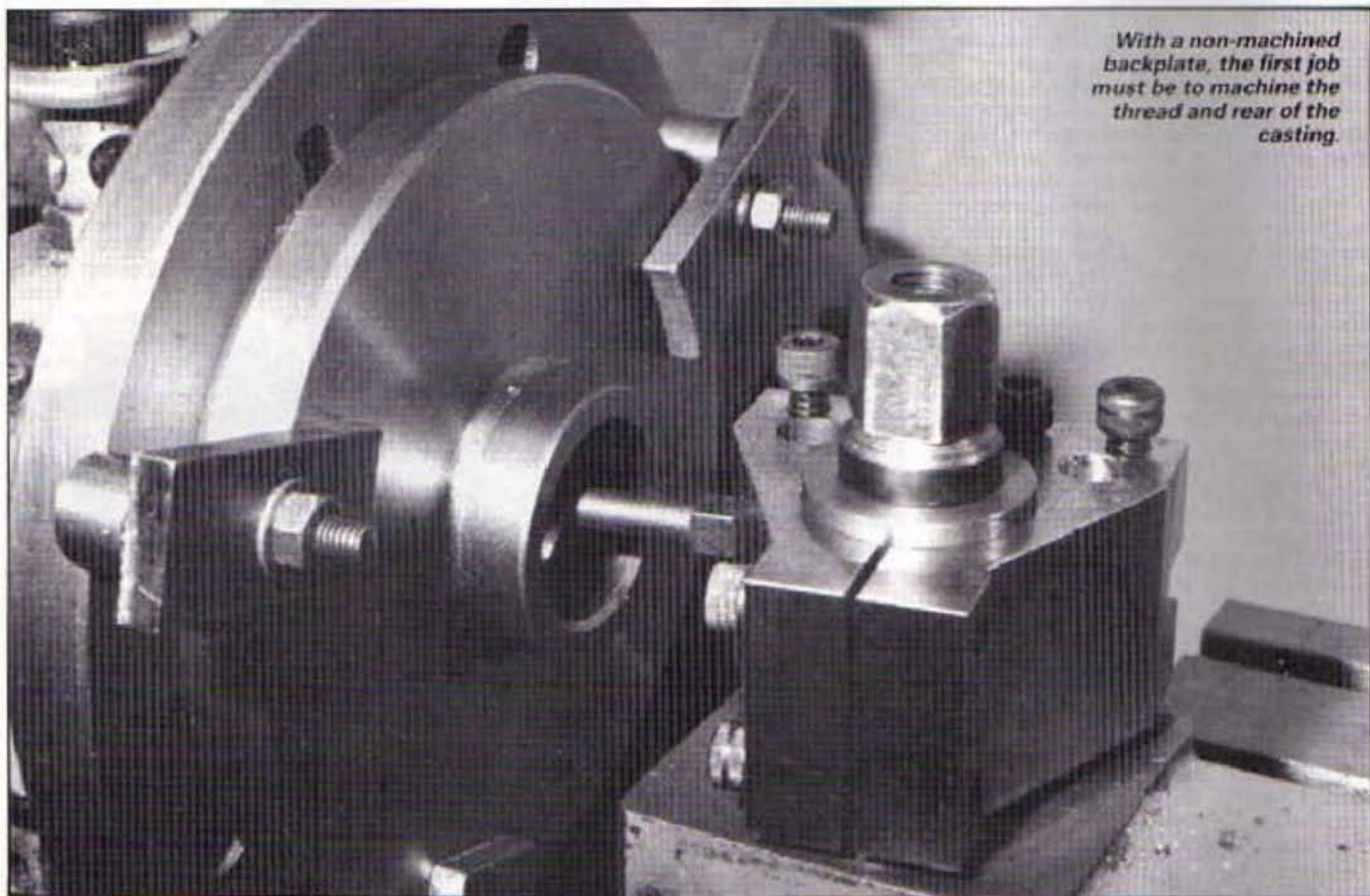
quite possible to purchase a backplate ready machined to fit the lathe, but not the chuck. Should anyone not have a non-machined casting, then the first step must be to machine it to fit the lathe mandrel. Assuming the mandrel is threaded; this will involve facing of the casting and boring and threading it. After threading, it will be necessary to turn away the first couple of threads to a size to duplicate the register on the nose of the lathe mandrel. It is not proposed to go into threading here as it has already been dealt with in other articles. The only thing to be said is that these operations will have to be carried out with the casting held on the faceplate. This will

involve careful mounting and clamping – that apart, the normal turning, boring and screwcutting operations will be needed.

Let us assume that the backplate casting has been machined at the rear and screw cut for the lathe, either by the supplier or by the operator. The next thing is to fit it accurately to the chuck, which will have a recess into which the backplate will fit. Start by facing across the casting which is mounted on the lathe mandrel. This will ensure that it is square to the lathe axis. It is now necessary to turn a lip to fit the chuck.

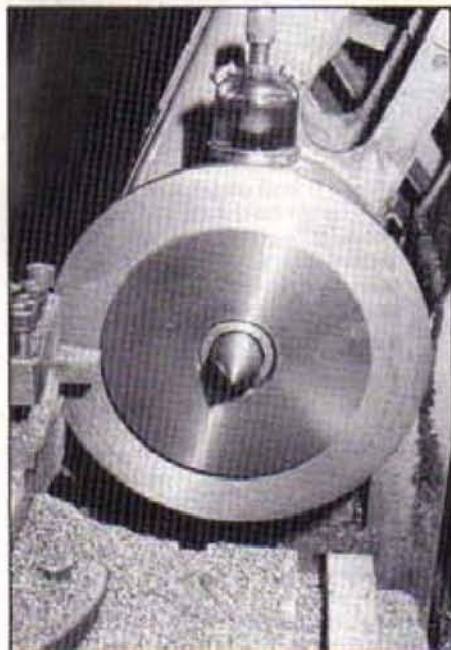
Machining the casting

Cutting should take place a little at a time, making a step of about 1mm to start with. The size of the diameter of the step must be carefully measured until it is nearing the required measurement. At this point, keep cuts to a minimum. It matters not how long it takes. Make a note of the cross slide reading at each cut and, after each one, offer the chuck up to the backplate after wiping away all machining dust. Eventually it will slip on to the lip. If there is some play, then we know that it is necessary to wind the tool back the tiniest fraction. Say the dial read twenty at that point; then make another series of cuts for



With a non-machined backplate, the first job must be to machine the thread and rear of the casting.

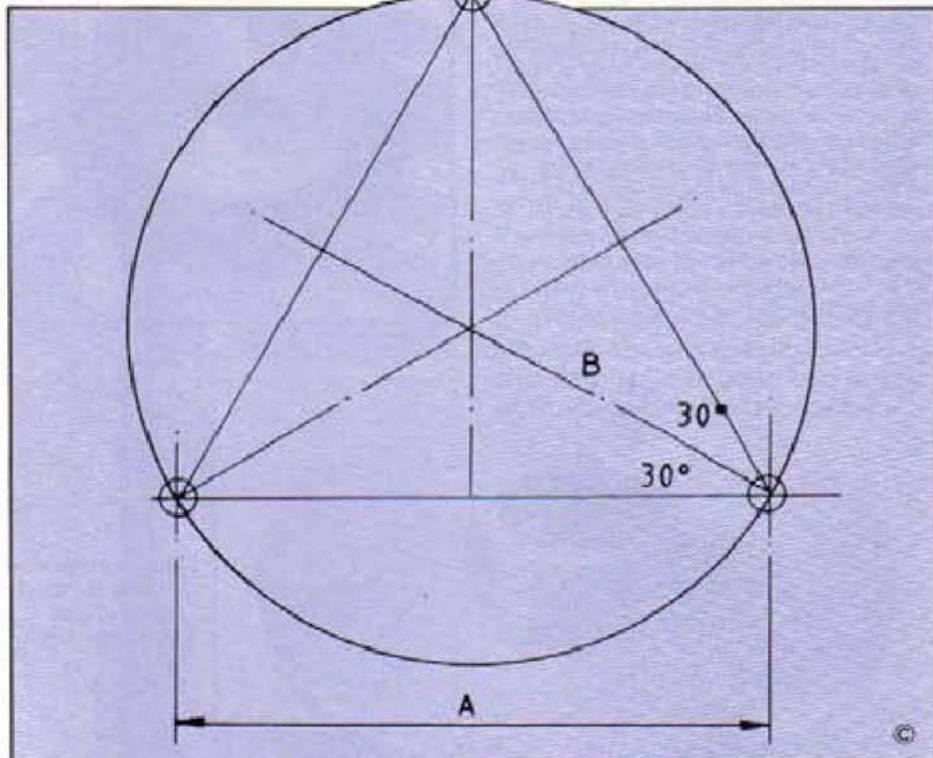
FITTING A CHUCK BACKPLATE



Screw the backplate casting to the lathe, face across and turn on the lip as explained in the text.

a length of about one millimetre until you get to the point where the dial reads around eighteen. See if that fits – it should not. Take the finest cuts again until the chuck will slide over the initial step but needs a good hefty push to get it on to the second one. It should, at that point, be just about right.

Face off the original step and machine almost to the new one leaving a step a little too long for the recess in the chuck. Machine to just short of the marks again and once more proceed in tiny steps until the chuck just fits over with a good push. Remember to wipe the dust away before trying it. Face across to get the step the required length, remove the burr and dust, and the chuck should, if pushed on the step, stay put. Do not however switch on the lathe. Take off the chuck and remove the backplate to the marking-out bench. It



A = CENTRES OF BOLTS

$$B = \frac{\frac{A}{2}}{\cos 30^\circ}$$

P.C.D. = 2B

is now necessary to drill the three holes for the fixing screws, but finding the right place can be a problem.

A vernier caliper is used to measure across the screw heads and obtain the p.c.d.

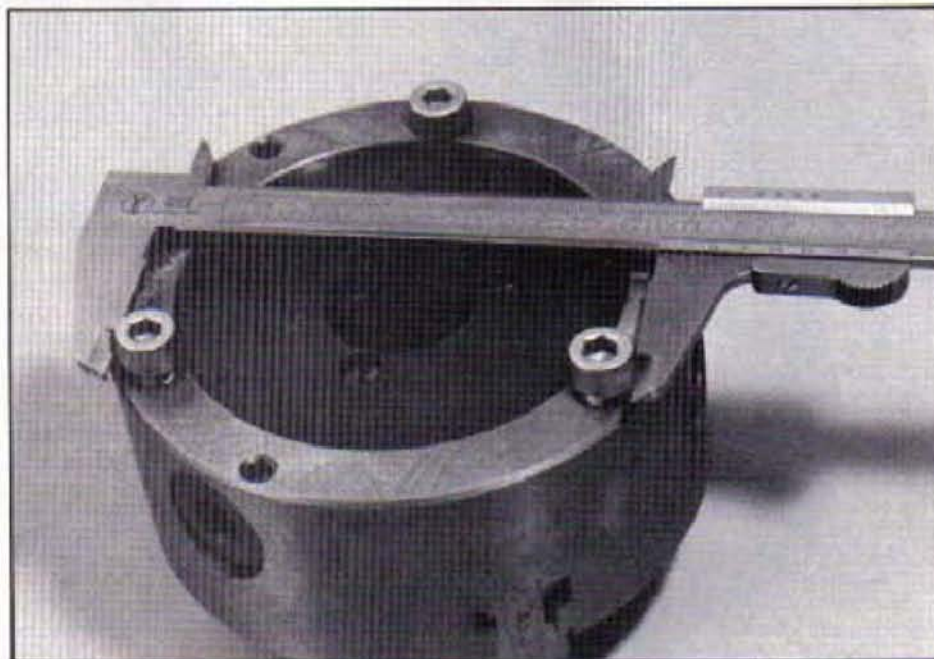
The screw fittings

It is normal these days to use cap head screws to fit chucks and, fortunately, good quality ones are also usually very accurate. We, therefore, have one thing in our favour! When it comes to finding the screw positions and we need to measure we can measure the cap of the screw and divide by two. All things being equal, we should be in the centre of our hole. If therefore we measure across two of the screws and take away the size of a cap screw head we have the distance between centres and from that, using the formula shown, we can work out our triangle and drill for the screws. The screw holes should be accurate, but the most important thing, of course, is the turned step.

There are some people who have never had to do more than basic arithmetic all their lives and who will find the formula difficult to work to. This is no criticism of these good folk; the engineer will have spent his life working out such things and it will be second nature. If one has spent the last fifty years selling cars, for example, any such maths learnt at school will long be forgotten and not easily recovered. In that case, some form of manual construction will be required.

Measure the distance from the edge of the chuck to the screw head, and add half the diameter of the head to the measurement. Fortunately, chuck manufacturers do not usually play tricks and so a nice round figure should be the

Measurement across the hole positions can be obtained by careful use of the calipers.



result. Measure the diameter of the chuck body and take away twice the measurement referred to and we have the diameter of the circle on which our screw will be placed, and we at last seem to be getting somewhere. Mount the backplate backwards on the lathe and scribe a line with a sharp pointed tool exactly at the centreline position of the screws. If the lathe does not have a screw-on mandrel, then it may not be possible to reverse the backplate and the line will have to be scribed with odd leg calipers. The work must be done very carefully in order to



Above, the completed backplate.



The backplate (at left) is fitted to the chuck using the Allen screws supplied.

Below, the fully completed job, ready for service in the model engineers' workshop.

maintain accuracy. Very accurately make a tiny centre punch mark on the line; it does not matter at which point. Measure the diameter of the circle and multiply it by 0.8660, this being what is known as a 'chord' of the circle, divided into three parts. The resultant figure is the distance between each of the three points we need. These can be measured and centre punched accurately and drilled.

Once again, we have a system which works perfectly but may cause problems to those working at home who could well lack facilities for measuring such a figure. After all, if we have a circle of exactly three inches then the figure we need is 2.598 in. and the equipment to measure that accurately is not all that easy to come by. Not many home workshops will possess a three inch micrometer and reading the vernier accurately may not be your cup of tea. Let us then look for a really easy way to go about things.

Using dividers

We have got our first position by simple arithmetic, and the use of a calculator, which most people seem to have these days, will give us our chord measurement. We need to transfer that to the backplate. Set a pair of dividers, as large a pair as possible, to as near that figure as possible. Do not be afraid to convert to a metric reading or, if working in metric, to an Imperial one. 2.598 in. actually gives us very nicely 6.6 millimetres or near enough to make no difference. Set the dividers to 6.5 millimetres using a rule, and open them just a cat's whisker. Lightly scribe arcs on the circle, one each side of the centre punch mark, with one point of the dividers

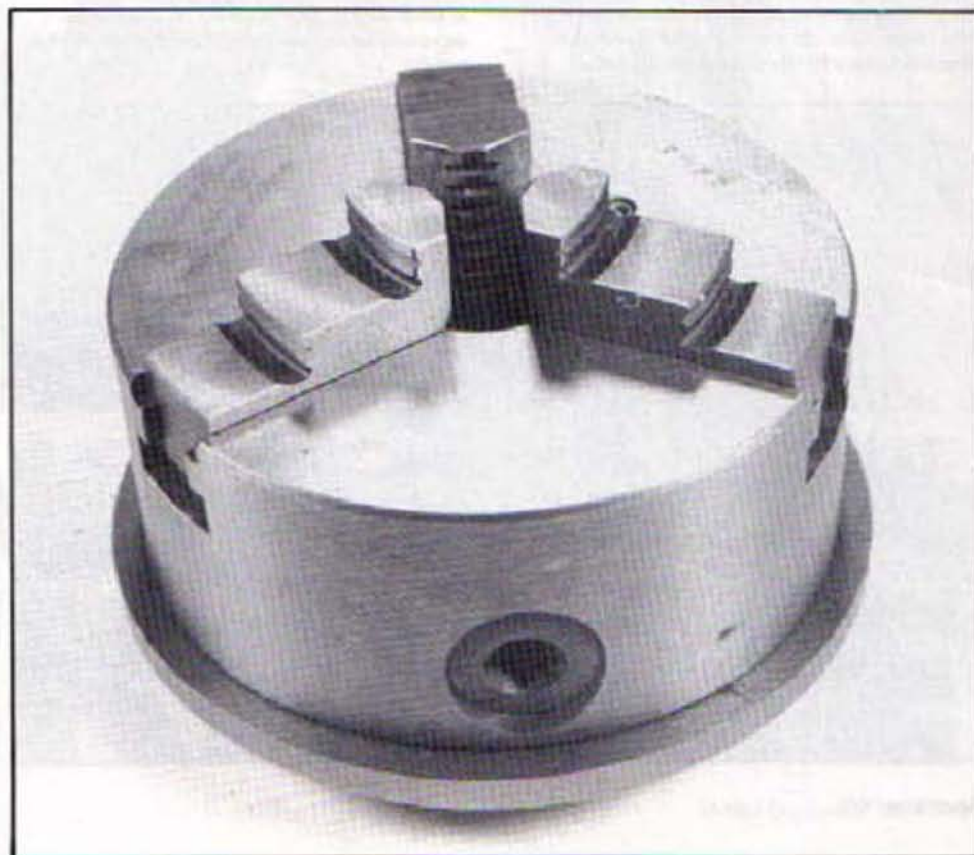
in the centre punch mark. See if the dividers fit from one of the scribed lines to the other when on the centre line. They will not, of course, but a slight adjustment can be made and two further arcs made. These should be a little nearer to the correct positions. The amount of movement put on the dividers initially will give some idea

how much more adjustment is needed and, with a bit of luck, another couple of arcs or so will find the position we require.

Once this is found, the marks can be carefully centre punched, making sure the correct arcs are used, as it is all too easy to centre punch the wrong ones, particularly if several trials have been made. The holes can then be drilled and should be right. The chuck should fit hard on the backplate lip and it should be possible to bolt it up without any effort.

We all have problems from time to time, and an important job like this is one that is likely to be problematical. Suppose we find that, in fact, our holes do not line up quite as accurately as we would wish. What can we do about it? Well possibly we could have another try, and if that went wrong another try and another, until the backplate looks like a pepper pot. It is most unlikely that there will be any serious mistake, so if things are wrong, drill out the holes to under the diameter of the screw heads but leaving play on the threads. We then need three thin washers the thickness of the lip on the backplate. When they are being drilled, put a piece of brass shim, say two to five thousandths of an inch thick, between one jaw and the material. We end up with three washers to fit our holes exactly on the outside diameter, but with holes a couple of thousandths of an inch or so out of true. Careful rotation of these should ensure that the screw will fit through the washer and into the chuck. The screws can then be tightened in the normal way. A similar method is sometimes used to actually true chucks on the backplate.

It must be said that, whilst the above is a get out of trouble dodge, there is no substitute for taking care and getting things accurate. The washer trick will work but will give problems for the rest of the life of the backplate, as every time it is taken off the chuck for cleaning, the washers must be realigned. We must, however, face the fact that mistakes happen, and that the less experienced may well be liable to make such errors. The advice is offered with that in mind....



SCRIBING BLOCKS

Sometimes called a 'surface gauge', the scribing block, which is referred to at length in the article on marking out, is a most important part of the workshop equipment. We show a series of photographs of a commercially made scribing block of reasonable quality, to give readers some idea of what the various parts can be used for. Cheaper tools are likely to be less sophisticated but will still work very well within their limitations.

A home-made scribing block

A complicated scribing block is not by any means necessary and making one's



The scriber adjustment on the block.

own is a good exercise, particularly for the less experienced reader. We offer therefore a design for a small scribing block which some readers may care to make for themselves.

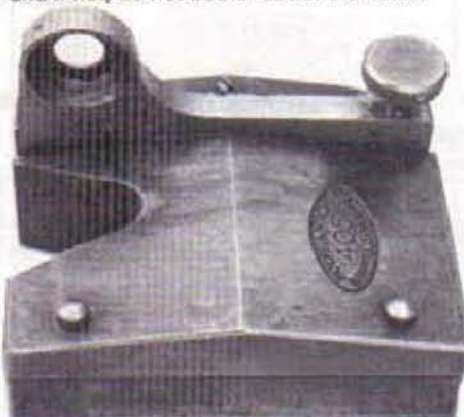
The base

The base is from a piece of mild steel two inches square by three quarters of an inch thick. Sizes are not very important, however, and any suitable piece of metal can be used. If the piece you acquire is not square at the ends, then put it in the four-jaw chuck on the lathe and face across it at each end until it is right. If you do not have, and cannot get hold of, a piece of



The commercially made scribing block.

rectangular section, then a piece of round bar, anything from 1½ in. to 2 in. diameter will do. The hole for the pillar should be made on the lathe to ensure it is square. It will be seen that the drawings show two other tapped holes; these are for lining-up pins and should be made before the pillar is set in position. Not everyone will wish to include the pins, although they are useful, and if not, do not bother about the holes.



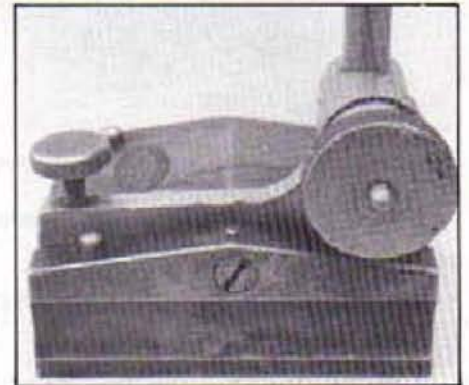
The base. The two pins act as guides along the edge of the materials to be marked out. Knob allows pillar to be angled for extra fine adjustment of the scriber.

The pillar

The pillar is made from a piece of ¾ in. diameter mild steel rod, but again, as long as all the other parts are made to fit, the diameter is not important and if a slightly smaller or larger section happens to be available, all well and good. The length of the rod is around ten inches or so, and each end should be faced square. The one

Although this article is intended as a form of supplement to the one on marking out, the simply constructed scribing block described herein will find many other uses. It can be used to set work reasonably accurately in the four-jaw chuck, and for checking the level of work in the milling machine vice, to mention just a couple of things. No castings are needed and it should not be beyond the scope of the beginner to the hobby

photographed has an embellishment on the top, an idea that can be copied if the reader so wishes. It serves no useful purpose. It is possible to drill the top of the pillar and insert a specially made scriber. This is quite a useful idea as it means a spare scriber is always to hand if needed and is simply pulled out for use. Such a scriber should, of course, have a small knob on the end to prevent danger from cuts when using the tool. The pillar is placed in the central hole in the base and secured with Loctite 601 or a similar retaining compound.



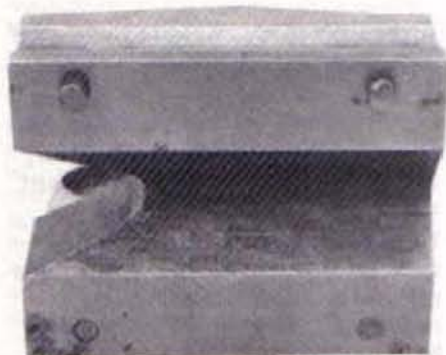
Base with pillar in place; large knob allows angle to be set as required.

The pivot block

The pivot block is made from a length of half inch square mild steel bar and has two holes drilled accurately across it. One is to accept the pillar and the other the pivot or scriber holder. A saw cut is made across the diameter of this latter hole and into the one for the pillar. The ends of the block are rounded off for cosmetic purposes.

The pivot (scriber holder)

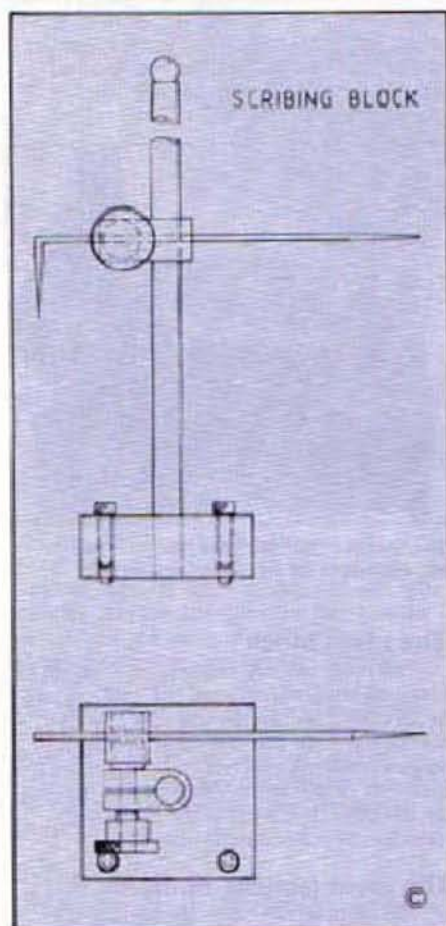
The pivot which holds the scriber is in two parts. The outer section is bored a close fit to the inner one with a stepped hole for the smaller section that passes through the pivot block. The two cross-holes will have to be drilled separately and for this reason are specified a little larger than the scriber diameter, it being no great fun trying to line up two holes of exactly the right diameter. When the thing is put under tension the movement will secure the scriber. The smaller diameter needs to be fairly accurate in length, and try to get a good clean thread, in order to make adjustment of the finished tool easy.



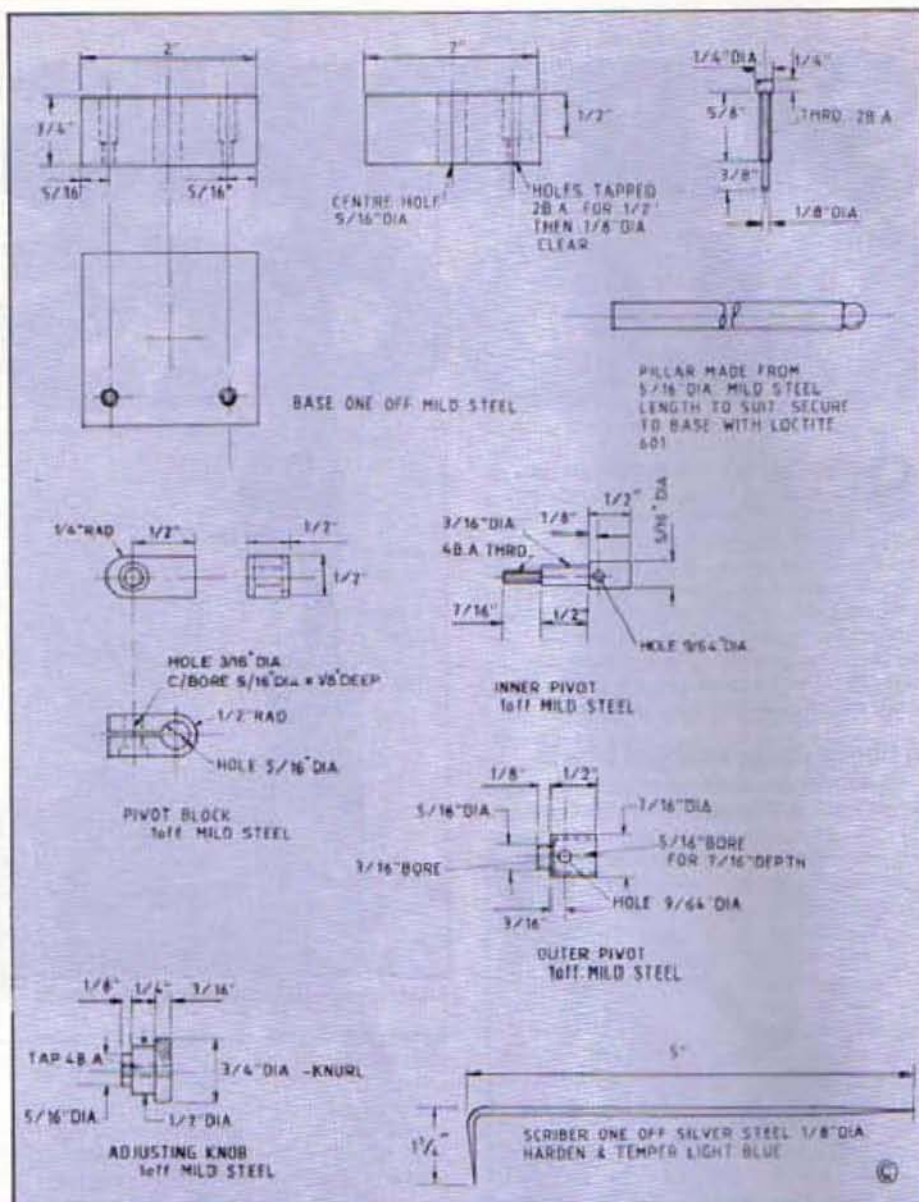
Underside of the base; groove allows the scribing block to be rested on curved surfaces.

The scriber

This is made from a length of silver steel $\frac{1}{8}$ in. diameter. A point is put on both ends to start with. This should have a gradual taper and then a sixty degree angle at the point itself. The correct way to do this is to turn the angles with a very sharp tool and it would be wrong of this magazine to encourage any other way. Wrong or not, there is little doubt that some readers will



file the point because of the difficulty in turning it, and while the practice is to be discouraged at least we can offer some safety rules if one has to resort to filing! First of all, no ties, and make sure sleeves are fastened up with elastic bands. Secondly, wear a glove; it is all too easy to catch the chuck if you must file with the lathe revolving and at least a glove catches the blood even if it does not stop the cut! Finally, use as fine a file as possible, ensure that it is fitted with a handle, and let the



Base of the home-made scribing block; pins screw in rather than being a push fit as on commercial types.

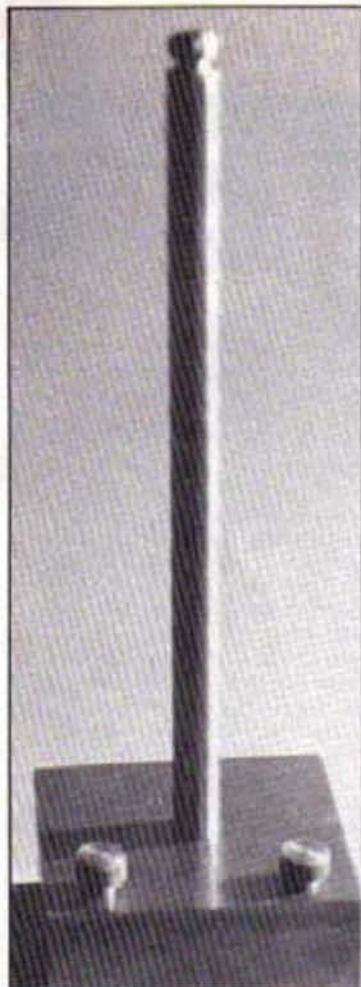
work rotate on the file rather than pushing the file backwards and forwards.

Why a fine file? If a coarse one is used, then there is greater chance of the metal which is revolving snatching and bending. If that is not reason enough, then a coarse file will make marks that cannot easily be removed from the work which will make hardening and tempering difficult.

The scriber when it has the points on each end should be heated to bright red and bent. The angle is a matter of choice, as is the position of the bend. Some like a short ninety degree bend, others require the bent section a little longer. Another



The parts for the scribing adjuster.



Pillar in position; there is no angular adjustment on this simple version.

opinion is that an angle of about thirty degree is sufficient. The bent section will be used for marking lower parts or awkward ones and the type of work will decide the shape of the scribe. When bent, harden each end, clean up and temper.

The knob which tightens or loosens the scribe should not need any description, being a straightforward turning job. The edges can be knurled to facilitate a grip.

The pins

The pins, like the knob, are a simple straightforward turning operation. Plain sections have been left on them, so that the depth to be tapped in the block is not unreasonable. The pins should be made of silver steel and hardened if possible. This makes them less likely to wear when drawn along an edge. However, if silver steel is not readily available, mild steel or even brass could be used.

More sophistication!

For those who want a block with finer adjustment, little more work is involved, but milling facilities, either on the lathe or the use of a milling machine, will be needed. A slightly thicker block is used and this is slotted across the top. A strip of mild steel is pivoted in this, and this is drilled across at right-angles to accept an adjusting screw. The pillar is mounted in this and, as the adjusting screw is wound in or out, so the pillar will move in an arc which means it will go either up or down as required. A casting for this form of base with drawing is available if required from College Engineering Supply, 2 Sandy Lane, Codsall, Wolverhampton WV8 1EG.



The completed scribing block. Complications have been avoided in this simple design but, nevertheless, fabricating the instrument represents a worthwhile workshop exercise.

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ABRASIVES

Abrasive materials are part of our everyday lives. We use them for cleaning things in the form of scouring powders, metal polish, and even toothpaste. They also have quite a big part to play in the workshop and, of course, it is this side of things it is proposed to deal with here.

Possibly the most usual type of abrasive we think about is the grindstone; without these we could not use our machinery. What is a grinding wheel and how does it work? All grinding wheels consist of minute particles of abrasive material held together with an adhesive that is moulded into the required shape so that it can be rotated on the grinding machine.

Abrasive types

Three types of abrasive are mainly used for making grindstones - aluminium oxide, silicon carbide, and white bauxite. Whichever is used the procedure for making them into grinding wheels is similar. They are first heated, then crushed and sieved, the sieving process separating them into the sizes of grain required. When we purchase a grinding wheel we often buy either a fine, coarse or medium; it would be more correct to specify the grit and this, in fact, refers to the size of the grains. These grades are subdivided over and over again and there are far too many divisions for us to worry about. However, each wheel should contain a code which will give the grain size and the bonding material.

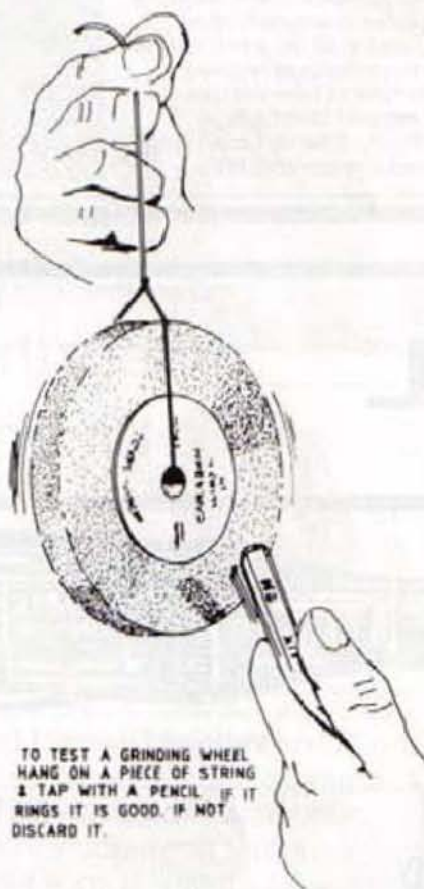
When purchased, the wheels have paper washers on each side and it is on one of these that the code is printed. The washers will also contain other information such as maximum speed of use for the wheel. This information should be strictly adhered to and the paper washers should never be removed as they are important to the strength of the wheel. Should they, by any mischance, become lost or damaged they should be replaced with new ones, even if these are home-made from thin card.

Mounting grinding wheels

Before mounting a new grinding wheel it should always be tested by holding it on a piece of string and tapping it with a pencil. If the wheel is sound it will have a ringing tone; if this tone is not present then the wheel should be discarded since it will almost certainly be cracked. Cracked wheels are very dangerous as they are likely to disintegrate in use and a grinding wheel that does this literally explodes and can cause nasty injuries. For this same reason, when fitting a new wheel or replacing an old one, do not overtighten it as this may also cause the wheel to break up when in use.

A grindstone works on the principle of wearing away the old and blunted particles of abrasive material, the new ones becoming prominent. It therefore becomes obvious that all the time the wheel is in use, small abrasive particles are being

Although this article is about abrasives generally, most important is the reference to grinding wheels. In the home workshop the grindstone, and particularly the grinding machine, is treated as just another machine. Its use without danger requires some knowledge of the hazards that can be involved. In industry only operators who have been on a course of instruction are allowed to change or trim grinding wheels. Some information on how to treat them and the potential dangers involved are referred to here



discarded from the wheel, and these usually fly off. For this reason safety glasses are essential. A suitable guard should also be on the grindstone as a further safety precaution.

Use of grinding wheels

Grinding wheels should, in theory at least, always be used on the periphery. In this way pressure is applied at the

strongest point. It is doubtful if many people in home workshops carry out this practice to the letter, and the majority of people will use the sides of the wheel because strictly adhering to the principle of the periphery only is not very practical. Whilst this is not to be encouraged it is almost inevitable. If it is a case that the use of the side of the wheel is essential, then pressure on it should be very light in order to avoid damage.

Wheels made from white silicon are very brittle, and only normally used for precision grinding. It is unlikely that the reader will come across one in the form of a normal wheel. The most common way we will find the white silicon wheel is in the form of a cup wheel. This, as the name implies, is in cup shape and such wheels are used on special grinders for sharpening tools such as milling cutters. They are ideal for this purpose as the shape lends itself to the sharpening of the cutting edges of these tools.

Carbide tooling cannot be sharpened with a normal grindstone and a wheel with a green grit is needed. Actually it is not the grit that is green (although that is how the wheels are referred to), it is the adhesive. It is particularly soft and wears away very quickly which allows a continuous supply of fresh material to be at the surface, thus allowing the carbide tools to be sharpened.

Finishing

All tools that have been ground will have minute burrs on them. If they are used in that condition the finish on the metal will be a little ragged. A small oilstone should therefore be used to hone the edges and remove the burrs before use. A stone such as this is really only a very fine grindstone, rolled out flat - the principle on which it works is exactly the same.

Abrasive papers and cloths

We will also come across abrasive materials in the form of papers and cloths. At one time simply known as sandpaper or emery paper/cloth, there is now a whole variety of types. They all have the same common purpose, and again consist of tiny abrasive particles, except now they are bonded to material. Like grinding wheels, a variety of grades is available. Some are designated as wet and dry papers and these are popular in the motor vehicle industry as they are particularly useful for smoothing paintwork and body filler. They can be used in the workshop with success. They are made with a special waterproof paper and in the motor industry are frequently soaked in water before use, to give an enhanced finish to the work. In the workshop, good results can be obtained by soaking them in oil before they are used.

Where possible, abrasive papers should be used with a backing such as a wooden block, or folded over a file. This ensures a good flat finish to the work. For some work where absolute even flatness is essential, the abrasive paper can be laid face up on a piece of plate glass or a surface plate, and



A photograph showing the paper label on a grinding wheel. At the top the grit size and make up. On the left the maximum speed at which it can be used and, below, the size of the wheel. Because the hole is of a larger diameter than the machine spindle a steel bush has been slipped in. This must be an easy push fit and under no circumstances should it be forced in. The paper washer must be left in place when the stone is mounted as it is part of the strength of the wheel.

the work rubbed over it using a figure-of-eight motion. This is a particularly useful idea for surfaces such as steam chests where a perfect mating surface between two components is required. If the figure-of-eight motion is not used, there is a danger of the work rocking, and reducing the size of the edges.

Liquids and powders

We are also likely, from time to time, to use powder or liquid abrasives – liquid abrasives are merely particles absorbed in water or oil. These are useful for running in parts. For example, if bearings have been made too tight, a little liquid abrasive can be used to get a good running finish. Such abrasive can be very fine, in the form of a metal cleaner such as Brasso or similar.

Parts such as valves can also be ground in with abrasives to get a good fitting seat. The normal type of substance used is a grinding paste – in other words, our particles are, in this instance, made up into a paste form. Grinding paste can be obtained, like wheels, in a variety of grades, but more usually only the coarse or fine grades are sold.

For high polishing of metal after the use of reducing grades of abrasive paper, metal polish can be used. Several other abrasive materials can also be used; wire wool is very good and another useful substance is known as Scotchbright. Sold as such in tool shops, a similar material is also obtainable as scouring pads in supermarkets and other household stores.

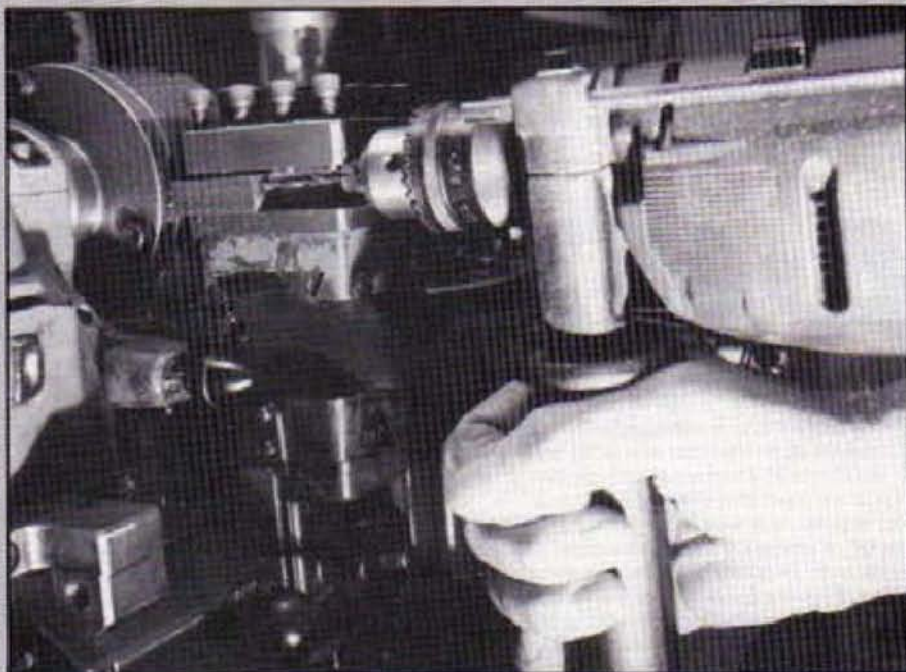
Safety

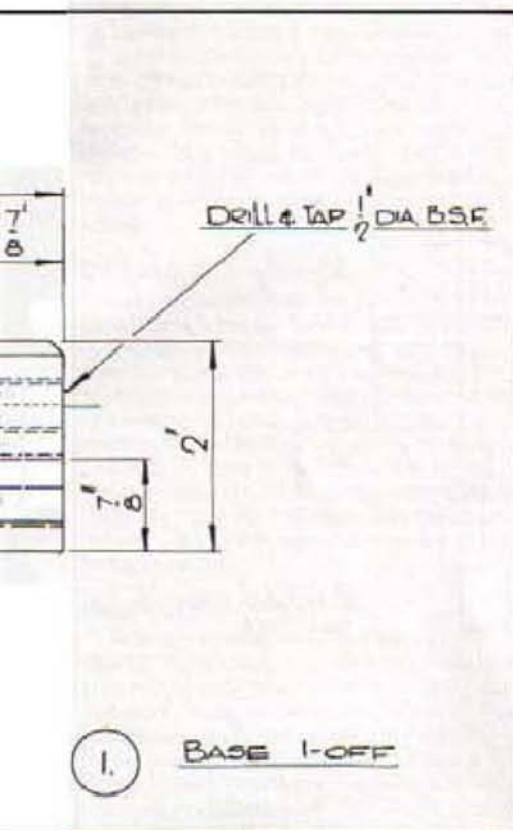
No matter what form of abrasive is to be used, it must be kept clear of machinery as far as is practical. It has already been pointed out how such materials work by the release of tiny particles; add this to oil from the machine and we have a perfect grinding paste which can wear a slide or bearing in no time. When abrasive materials are used in the workshop, it is a wise precaution to cover machinery to prevent particles descending on it. Better still, if at all possible do not use the materials in the same building.

QUICK TIP

Making the toolpost grinder or a similar device is the ideal way of cross drilling in the lathe. Sometimes the drilling may be needed at a place where the equipment will not have access. Keep in stock a piece of square or rectangular bar that has been drilled at centre height, parallel from the lathe chuck. The hole need only be about $\frac{1}{2}$ in. diameter. An ordinary handheld electric drill can be used for the cross drilling by using this as a jig. It can also be used for holes in line with the lathe mandrel.

An accurately drilled block is used as a drilling guide.





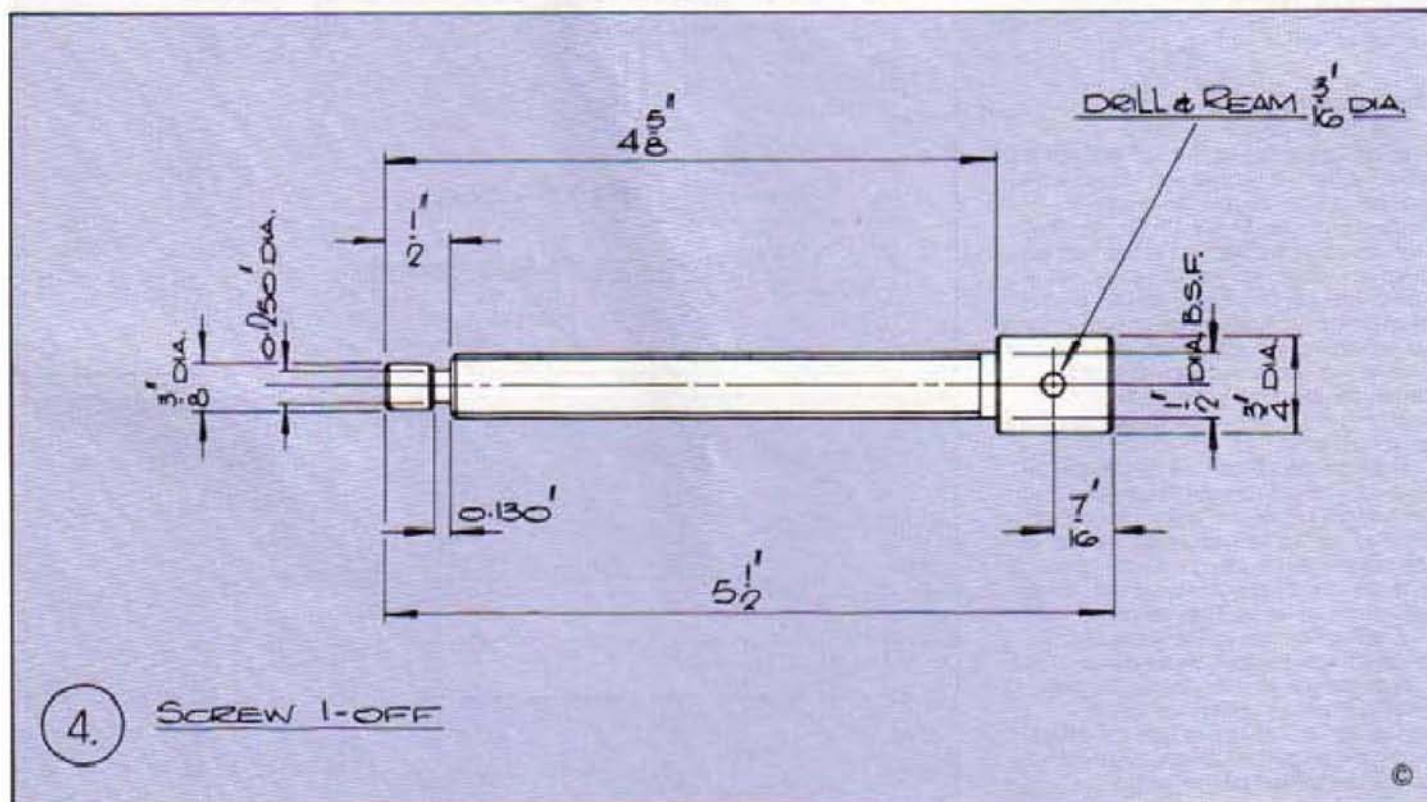
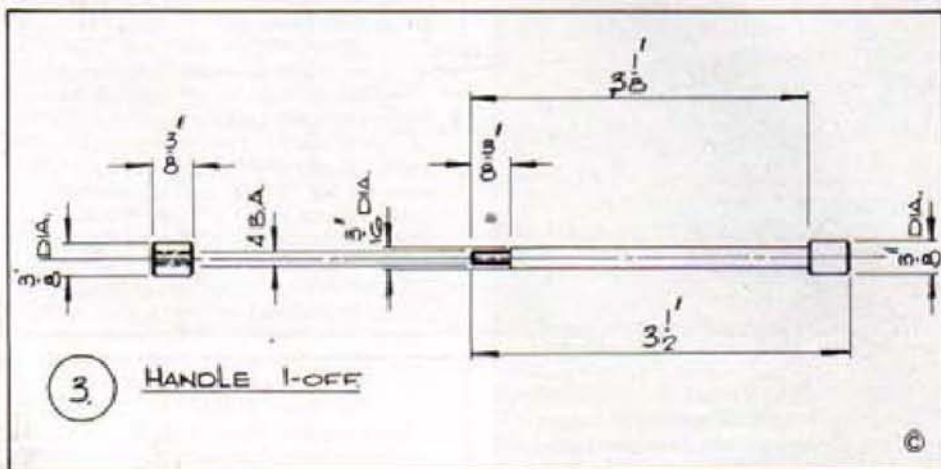
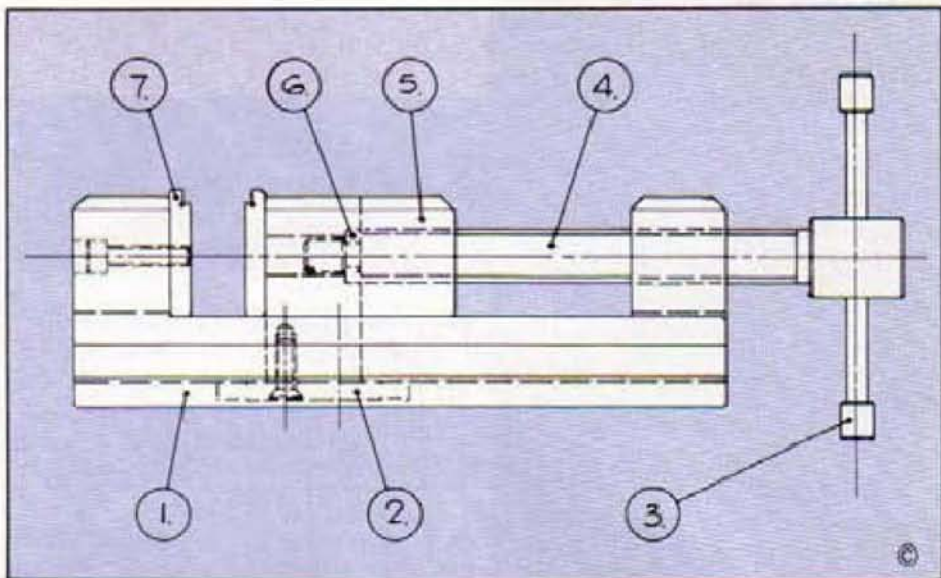
passes through is shown as reduced in width, it can be left full width if one should so wish. The necessary holes can be drilled and tapped.

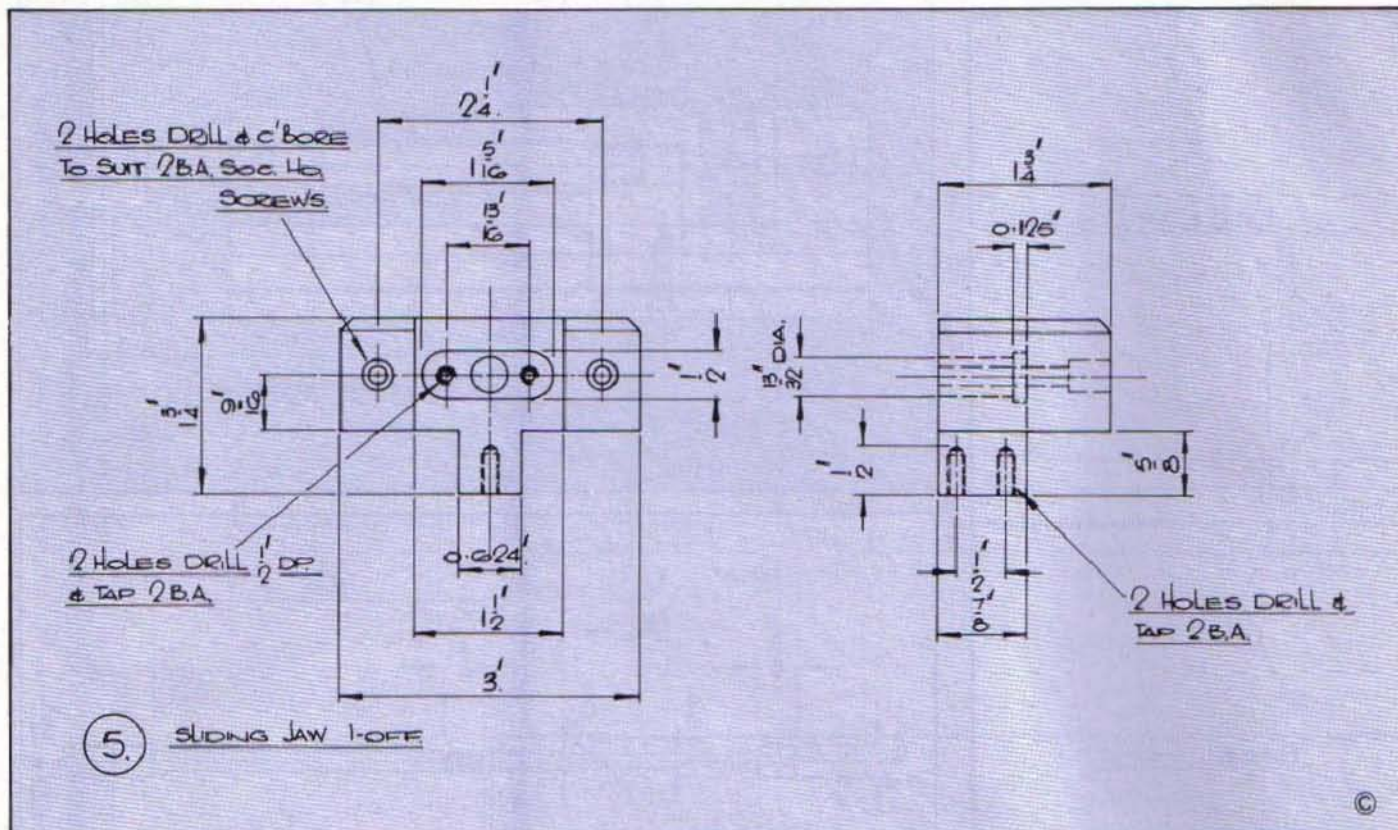
The lead screw

Tapping the half inch diameter thread is not an easy proposition as it is difficult to keep that size of thread straight. It is possible to screwcut it first which will help. To do this, mount the body on the cross slide of the lathe, ensuring that the hole

with which we are concerned is at exact centre height. Make up a small round boring tool with a cutting edge suitable for the thread, ie an angle of 55 or 60 degrees depending on which thread will be required. (Not everyone will want to use BSF). Set the change wheels or gearbox to

the desired thread and adjust the tool so that it will just cut the whole of the circumference of the hole. The lathe can be started up and as the saddle travels forward the thread will be started. Adjustments are made on the tool until the thread is nearly at the correct depth and a





tap can be used to finish it off.

Part two, the retaining plate, is easy enough and should need no explanation. Originally it was shorter than shown, the additional length helps keep the loose jaw down when it is tightened onto work.

The screw and handle

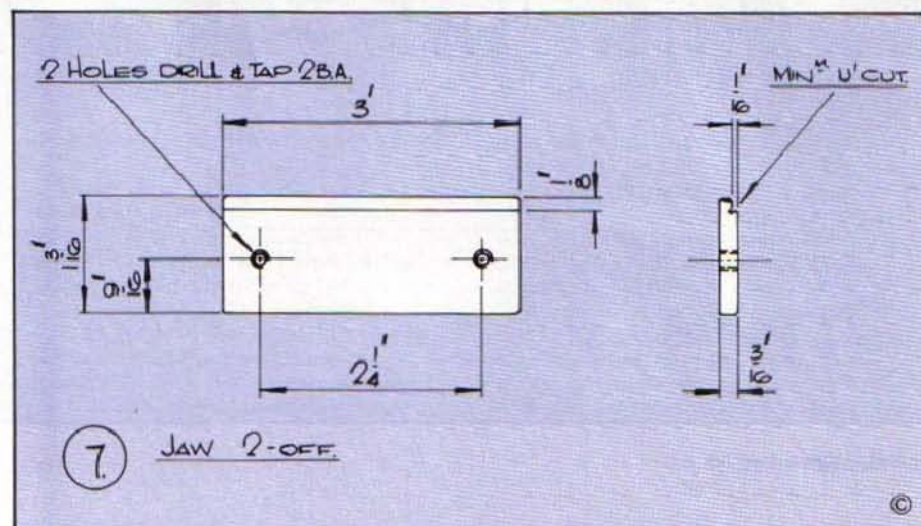
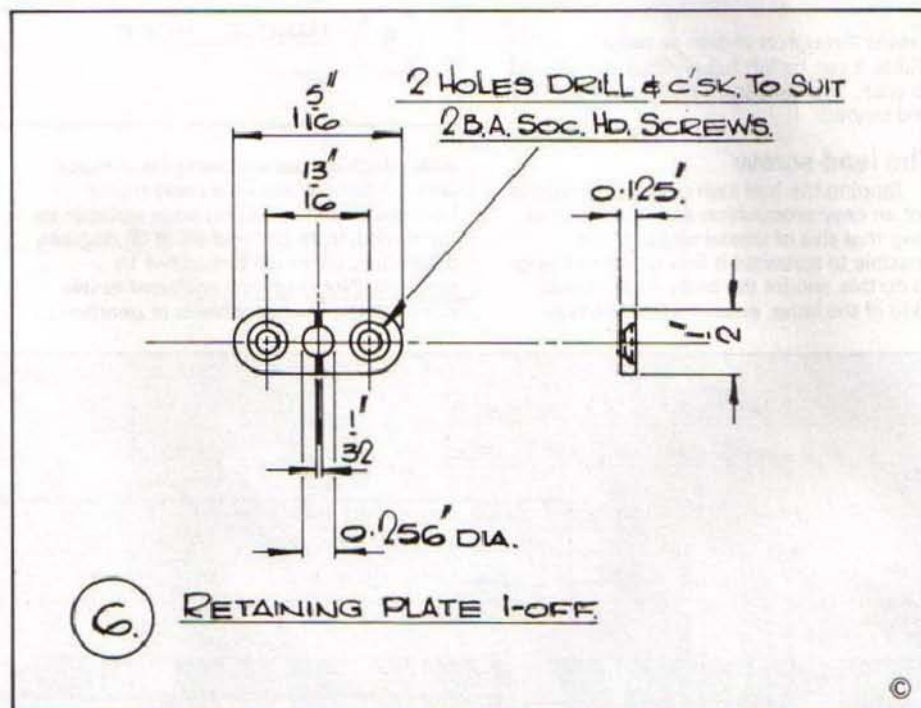
Parts three and four are straightforward turning and drilling operations and need little explanation, except to say that the half inch diameter thread on the screw should again be cut on the lathe before using a die, in order to keep it square.

The moving jaw

The first thought for part five is probably, "how do I hold that?" It is not too difficult. Clamp it on end and machine the first half of the step, but leave a few thousandths of an inch for finishing. The metal can then be laid on the top face and clamped by the step that has just been cut, machining to finished size. Make a note of the machine graduations on the downward movement in particular. Move the clamp to the new stepped area and finish off the machining using the graduation measurement to ensure that both steps are equal in depth.

The holes can be drilled and tapped as required. Those to accept the screws from part two should be marked off from that part. Part six is a retaining plate for the lead screw and again is straightforward enough, parts seven are the outer jaws and should need no explanation. They can be of mild steel, but gauge plate, which can be hardened, would be an improvement.

That really is all there is to it. On the drawing it looks a pretty formidable proposition, but once one gets the idea of finding the correct sequence to machining there is not a great deal involved.



inevitably, part of the metal work carried out with machinery in the model engineer's workshop will, sooner or later, involve the making of holes or recesses. We can do this in a variety of ways; smaller holes are usually made with drills, and for that reason the operation is known as drilling. Larger holes need to be bored.

Drilling

Let us take work on the lathe first of all. Suppose we need a hole of, say, one inch or twenty five millimetres diameter. It is possible that some of us will have a drill designated as being of that diameter. Drills, however, and particularly large diameter ones, are notable for their ability to drill oversize, or even make a hole that is not truly circular. If the hole is required to pass a bolt through, then that matters little; but if greater precision is needed, then we need a better method.

Reaming

A better method is to drill a hole very slightly undersized, and then ream the hole. This will usually ensure that it is round, but does not always mean a hole is true to size. Certainly, it is very successful for smaller diameters, but for large ones to make sure of the required accuracy we need to bore the hole, and for this we will need a boring bar of some sort. Actually, the use of a boring bar need not be limited to large diameter holes as very tiny boring bars can be used for quite small holes and the end result, if care is taken, will be a very accurate hole.

BORING

The necessity to bore holes when making objects with metal goes almost without saying. In this article the general principles of boring in the lathe are discussed, other methods being used from time to time with a milling machine. The construction of several boring tools is described and these can be made in various sizes to make eventually a useful set of equipment

Boring bars

Boring bars can be purchased and usually those sold by reputable suppliers are very good. There is only one snag to buying them; we are limited to the manufacturers' size and shape, which is not always suitable for the work at present in hand. The largest boring bar practicable should always be used. This is fairly obvious if we stop to think about it. Most readers will be familiar with the situation that goes wrong from time to time on a lathe, and have been surprised that even the heaviest chunk of metal can be persuaded quite easily to move. So it is with a boring bar. The bar always tends to be pushed away by the work, and the thinner the bar the further it can be pushed. So we really need to acquire a number of boring tools of differing diameters.

This is not to suggest that we need immediately to start and make a dozen

different sizes. They can be made as required, and are very easy to construct. It is surprising how soon a selection of tools is acquired, and there is no need to make any more unless a special job is in progress. The actual tool should be removable so that it can be changed as need be and will cover a range of purposes.

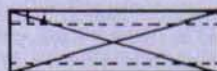
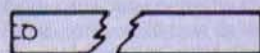
Home-made boring bars

A simple type of boring tool can be made from a piece of square or rectangular bar. Mount it in the toolpost in which it will be used, after facing the ends square. Put a centre-drill in the lathe chuck and centre the bar. If you wish, a drill of the same diameter as the bar to be used can be put in the chuck and the holder as the square bar is, can be drilled in situ. If this is not your cup of tea, then mount the square piece in the four-jaw chuck and drill it after centring it with a wiggler. There is no need

BORING BAR HOLDER

BORING BAR FOR THROUGH HOLE BORING

TOOL
SECURED
WITH
GRUB
SCREW



BORE TO
SUIT BORING
BAR

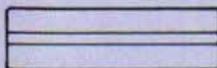
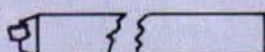


FIT 4B.A. OR
SIMILAR GRUB SCREW
TO SECURE BAR IN
POSITION.

NOTE:- BARS SHOULD BE OF
AS LARGE DIAMETER
AS POSSIBLE & THE
SECTION IN USE AS
SHORT AS POSSIBLE.

BORING BAR FOR BLIND HOLE BORING

30° ANGLE



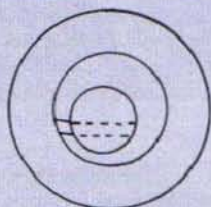
SLOT 1/16" TO 1/8" WIDE
FULL LENGTH OF HOLDER.



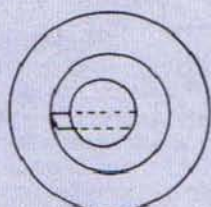
for any great accuracy. Whichever method is adopted, the end result should be a nice little holder to take a suitable boring bar. Some people like to make a holder for each bar, others will make one large holder, and use the same size of bar each time, with the end to be used for machining turned to a suitable diameter.

A screw can be used to hold the boring bar in the holder. There is much to be said for using a socket headed cap screw as it is possible to get these really tight. They do tend to bring up burrs on the boring bars though and so precautions must be taken to prevent the bar being jammed in the holder by a burr. A slight flat on the bar will take care of it, but then there is the disadvantage that it is not possible to twist the bar in the holder, something that can at times be desirable. Alternatives are to use a square or hexagon headed brass screw, which will burr over at the end as it grips the bar. The burring is not a disaster as a good tweak with the spanner will remove the burr as the screw is withdrawn. We can also use our cap headed screw but slip a small brass plug between it and the boring bar. The burr then occurs on the brass plug rather than on the bar.

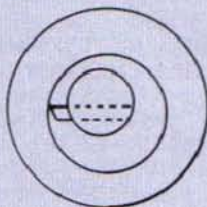
The actual bar can be of mild steel and should be drilled across for the tool. This can either come straight across the bar, or it can be at an angle at the front, by first chamfering the end of the bar. The latter idea is necessary for making blind bores or recesses, but for through bores the bar



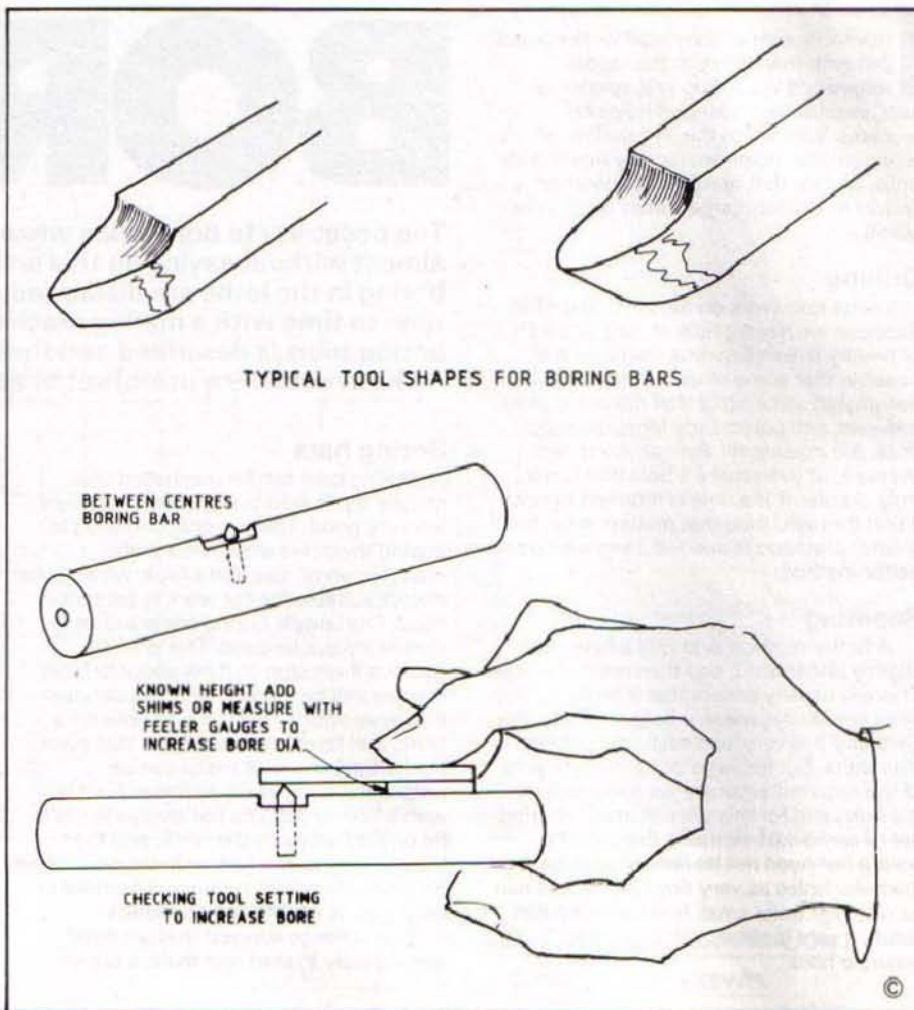
WITH BORING BAR BELOW CENTRE HEIGHT TOOL WILL INEVITABLY FOUL WORK ON ITS LOWER EDGE.



TOOL AT CENTRE HEIGHT HAS MORE CHANCE OF CLEARANCE. IF IT ASSISTS GRIND TOOL TO STEEPER ANGLE.



TOOL ABOVE CENTRE HEIGHT BUT THERE ARE NONE OF THE PROBLEMS ASSOCIATED WITH NORMAL TURNING & THERE IS A GOOD CLEARANCE AT THE LOWER EDGE.



drilled straight across is as good as anything. A grub screw holds the tool in position, and the tool should be ground from high speed steel, or even solid carbide if available. The shape of the tool is similar to that of a turning tool, and can be round nosed for heavy roughing or fine finishing.

Some modification to the tool may be required as there is always the danger of the non-cutting section rubbing on the bore. This will either damage the bore or push the tool out of line. Either way, it will not do a lot of good for your efforts. A check therefore must be made to see if this is likely to happen and, if so, to grind the tool away a little to get the required clearance.

If tool holders are made with through bores, then a boring bar can pass right through and only the shortest possible section used for machining. It is always desirable to do this if possible. The actual length of bar in use should be kept as short as practical in order to avoid unnecessary whip when in use. Through bores in the holders also allow the use of double-ended boring bars, meaning a saving in material and time looking for that elusive bar that was put down a second or so ago and has now gone for a walk!

Mounting work

A lot of work to be bored, such as cylinders and the like, can be mounted in



Typical, simply made boring tool, this one a boring bar for blind hole boring. See diagram on previous page.



A double-ended boring bar; end with the taper is for blind boring, other end is for through-hole boring.

the four-jaw chuck, on a faceplate etc. The Keats Angle Plate can be particularly useful for this. It should be centred accurately before operations begin and tightened up as hard as possible. If there is no hole in it, then it should be centre drilled and drilled before boring operations begin. The boring bar must be passed through the work very slowly. It is desirable that it should be in contact with the whole of the circumference, but sometimes with previously cored holes in castings this is not at all practical. This intermittent contact with the work is known as an 'interrupted' cut, and only a very small depth of cut should be used in such cases, as, once again, the tool will tend to whip sideways as it is struck by the rotating work.



Slotted boring bar holder; note slot is full length.

Machining operations

Once a complete circumference is being machined, the graduations on the lathe can be used for calculating the bore size. The diameter should, however, be checked for size when it is known to be nearing completion. Several cuts should be taken on the final setting to ensure that any deflection of the tool is countered. Do not cut the metal in both directions; most lathes will cut at different depths according to the direction of feed. There is nothing more annoying than proudly getting a bore exactly to size only to find that a cut in the opposite direction has caused it to go oversize.

Other methods

So far so good. For accurate boring we do not need expensive tools but can do very well with simple home-made items. Thus far, however, we have only discussed work that will fit on the faceplate or in the lathe chuck. This is not always possible and in these cases other methods must be used. The most common of these is to mount the work on the saddle of the lathe and to use a boring bar rotating in the mandrel.

Mounting work on the saddle

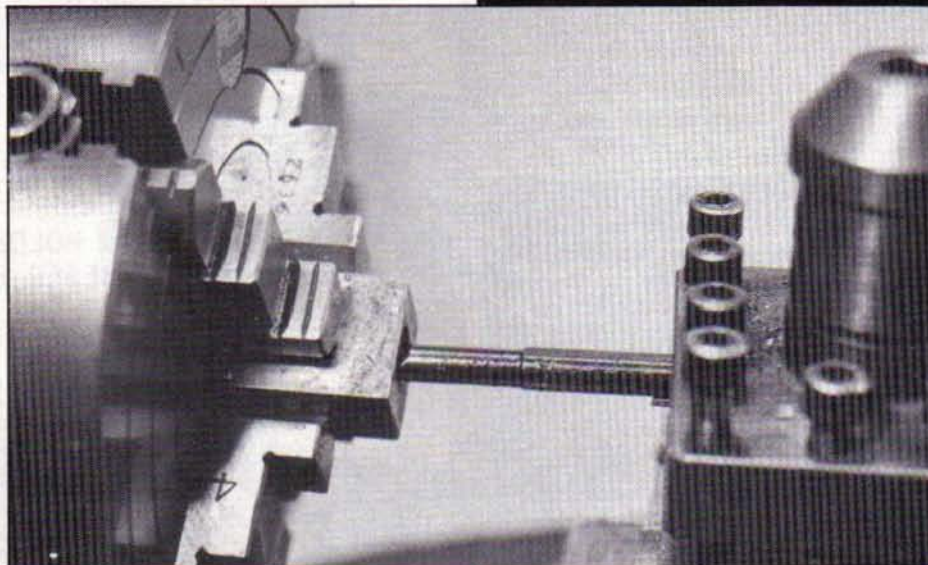
Firstly, we must mount the work accurately, which is not always as easy as it may sound. Almost certainly, packing will be needed and to get the exact height

some shims as well. The work must also be square to the mandrel and, here again, considerable care is needed to get it accurate. If the work is cored, then a piece of round bar as near the core diameter as possible can be pushed through and a dial test indicator used to line it up. Of course, if we just leave the metal bar in the hole in the casting it will move when the indicator

improvisation will be needed. A vee block is an obvious solution, but at times it may be necessary to make up a special fixture with which to get the required support.

Using an improvised boring tool

Most work that is bored on the saddle will be done with a between-centres boring



A small boring tool, being used here to bore an accurate hole of quite small diameter.

makes contact. The best way is to pack the side opposite the indicator with Blu-Tak so that a small force will be needed to obtain movement.

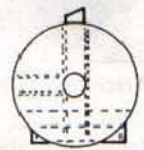
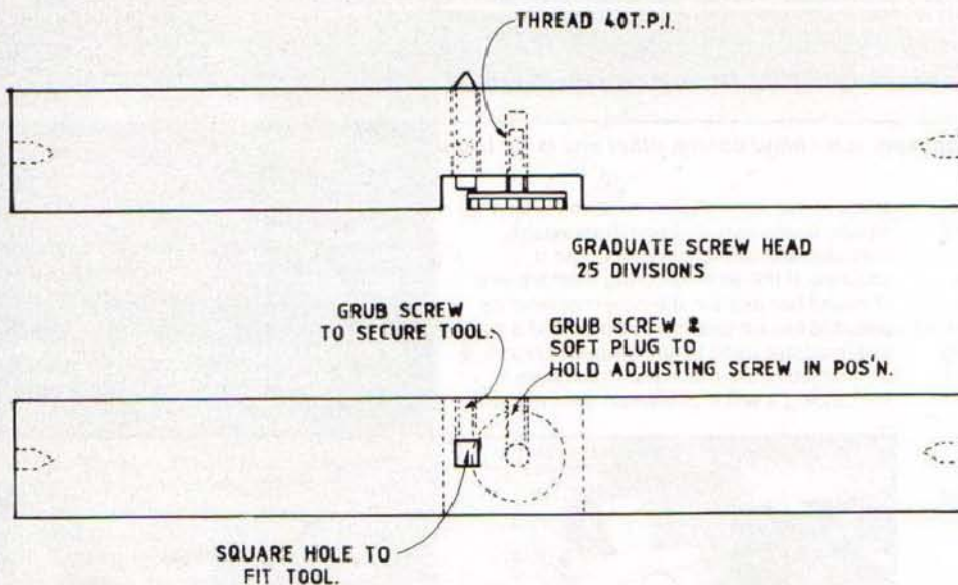
If the cored hole is not too large, it may be practical to use the lathe centres to line it up. Some times, as with, say, a model locomotive cylinder, there may be a flat section that must be machined parallel to the bore. If so, this can be used as the setting-up aid; however, all too frequently, this flat surface will be needed to support the work on the saddle as apart from packing to centre height a rigid support surface will be needed. If there is no flat section on a casting, then some means of

bar. Here again, we will need to make one. They are obtainable commercially, but usually the minimum thickness is about one inch and that all too frequently will be too big, even if one is willing to spend hard-earned cash on a tool that will rarely be used. If for any reason the between-centre bar cannot be made up, or indeed if the bore to be machined is blind, then a square shanked boring bar in the four-jaw chuck will do the job very well. Adjustments can be made by releasing one jaw and tightening the opposite one. Be sure that the same jaws are used each time, otherwise the end result will be very odd indeed...



A between-centres boring bar; central screw provides graduated advance adjustment. Bar at left-hand end is the drive dog.

ADJUSTABLE BETWEEN CENTRES BORING BAR - SIZES TO SUIT WORK



©

Between-centres boring bar

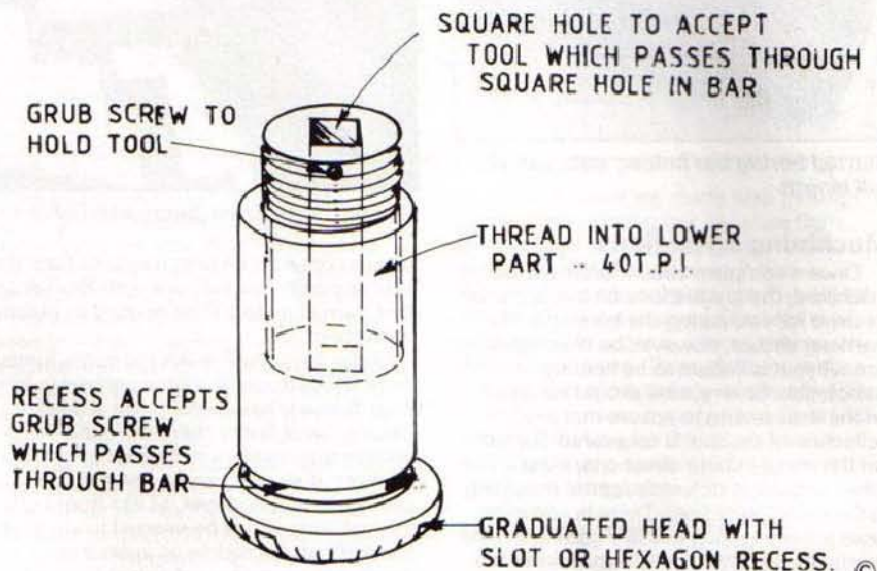
There is nothing special about this tool. A length of round bar of suitable diameter is cross-drilled to take a cutting tool, and a hole is drilled and tapped to hold a grub screw to secure it in the position in which it is set. The bar, having been previously centred at each end, is simply placed between the lathe centres and driven with a driving dog, either from the driving plate or from the faceplate. If a carrier is to be used, then a flat must be machined or filed on the bar to accept the holding screw. An alternative is to drill and tap the bar and fit a peg. This system takes less room than the carrier.

Points to remember when making between-centres bars are to use as thick a bar as possible, and to remember the length required; the cutting tool must be able to pass right through the work. It is surprising how easy it is to underestimate the length required.

Machining operations

All that is required for machining is to set the tool so that it will remove the amount of metal required and to pass it slowly through the work with the lathe rotating slowly. As with the ordinary boring

ALTERNATIVE TOOL HOLDER/ADJUSTER FOR LARGE DIAMETER BARS



©



One way of lining up an object in order to bore it between centres is to swing it on the lathe centres and gradually fit shims beneath until component is at centre height.

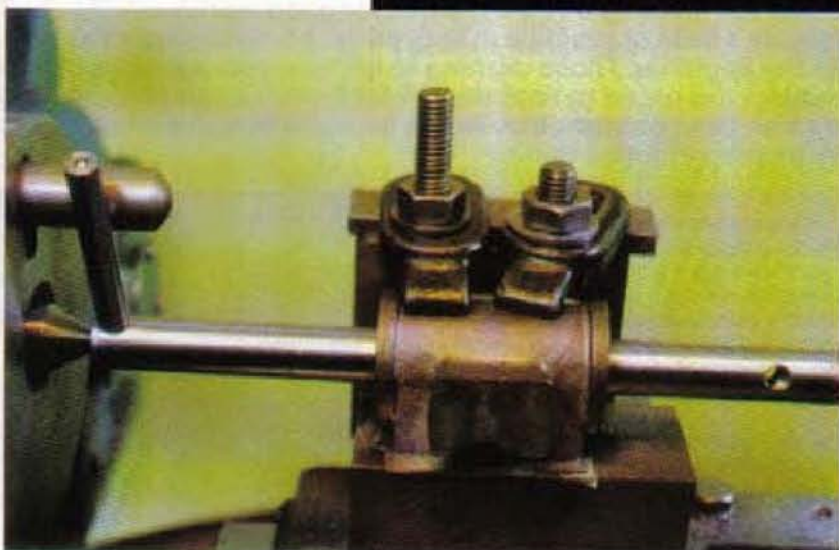
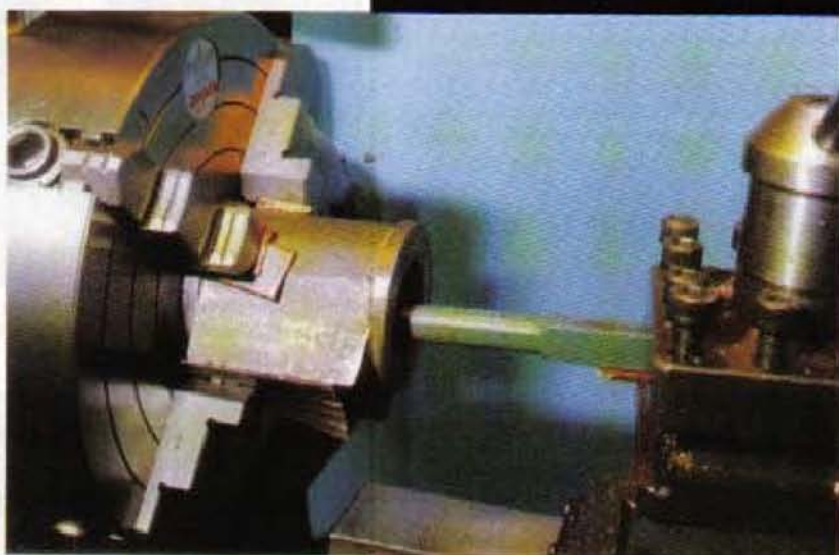
bar, cutting should take place in one direction only. The tool must be adjusted after each pass to allow the next cut to be made.

Tool adjustments

Adjusting the tool is not all that easy unless some form of guide is used, it being very difficult to estimate just how much the tool has been brought out of the slot or hole in which it is held. It is possible to make boring bars with adjusters but only in the larger sizes. For the ordinary bar a guide is required. One easy way of getting this is to file a flat on the bar where the tool protrudes. We now know that if we lay a piece of metal strip along the bar and it is just touching the tip of the tool then this is in line with, and operating at, the exact diameter of the bar. Put a feeler gauge or shim of, say, ten thousandths of an inch



Above top: a boring bar being drilled. Above: for a blind bore, the tool must be set at an angle to protrude forwards. Here the machine vice is packed to a suitable angle to enable such a tool to be cross-drilled. Above right: a cylinder mounted in the four-jaw chuck for the purpose of boring. Right: a cylinder mounted on the cross slide and bored with a between-centres boring tool.



underneath the guide, and then adjust the tool which will cut the bore twenty thousandths of an inch larger than the diameter of the bar (ten for each side). For the next cut, add a further ten and so on and in this way a very high degree of accuracy can be obtained.

The only very slight snag with the method outlined above is the fact that the number of shims or feelers can get out of hand. It is a good idea therefore to make up some thickness pieces. We can still use the

feelers or shims but if we have a thickness piece of, say, $\frac{1}{16}$ in. and set the tool to that, then we know the hole will be bored $\frac{1}{16}$ in. larger than the diameter of the bar. Shims can be used to set cuts until we can use our next piece with the fixed thickness section on it.

Adjustable bars

To make an adjustable boring bar we need a means of raising the tool by a

known distance against a measurement on the boring bar. The first requisite is a tool that will not rotate. Whilst we can successfully use a round tool in the ordinary bar, in the adjustable one we really need to have a square one. An alternative might be to grind a flat on the tool, but this would need to be absolutely even all the way along.

The height adjustment is made with a screw. A large flat headed one, the underside lip of which pushes on the tool, or the actual screw end can be used if there is room. Either way, the screw must be capable of accepting graduations; it follows that the thread pitch must be easily divisible. For an Imperial thread, forty to the inch is ideal. The head can be graduated into twenty five, and so every mark represents one thousandth of an inch. In the case of a Metric version, a half millimetre pitch can be used, and the head graduated into twenty divisions. We now

have one tenth of a millimetre movement for each mark.

The adjusting screw and the tool should both have locking screws, and it is essential to ensure that the tool is in contact with the screw when adjustments are made. This apart, the system is quite reliable and is well worth while exploring.

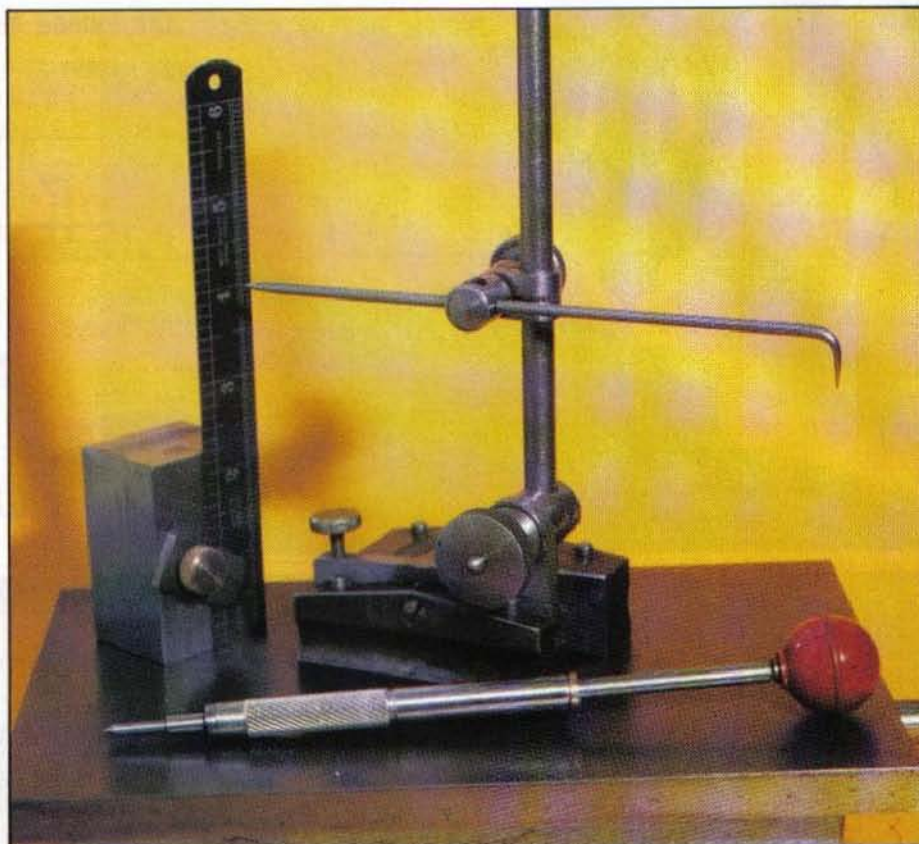
With a little experience, the beginner will find that hole boring is a very straightforward operation and will present no difficulties to the operator.



The importance of accurate marking out can not be over emphasised. Upon the accuracy of this will, to a large extent, depend the accuracy of the work, and the working ability of the finished product. Metal working is not the only skill where marking out is required. The woodworker, for example, must first mark the work before proceeding. Indeed, almost anything that is manufactured will need some form of marking to give the constructor suitable guidelines. The difference as far as we are concerned is that we will mostly be marking on metal. This in itself can pose some problems as it is necessary to score the metal to see the mark.

Marking fluids

If we use a scribe, which is a fine pointed, hardened and tempered tool, we can scratch metal. These scratches, if properly organised, can be used as the guidelines we need. However, suppose we scratch a nice shiny piece of steel. The original steel is silvery colour and so is the scratch, and the result is that the scratch is difficult to see. What is needed is to change the colour of the steel so that our mark will show silver against the revised colour of the material. Marking fluids can be bought in a variety of colours, and they can either be brushed on or can be obtained in spray cans for spraying onto the metal. They are very good, and the scratchmarks really do show up against them. We can therefore coat our metal with the marking fluid and happily go on our way.



A typical marking out set-up; the rule holder and dot punch seen in this illustration are both described elsewhere in this issue.

MARKING OUT

Accurate marking out is essential for good workmanship. It is largely a case of practice makes perfect but here we offer some tips to the beginner. Those wishing to become more proficient in the subject are urged to read the book *Measuring and Marking Metals* by Ivan Law; published by Argus Books, it is Number Six in the Workshop Practice Series

There is a snag, but then there always is! Marking fluids are of necessity dilutable, and if we mark a piece of metal to be used in the lathe or the milling machine, the oil or other cutting substance will dilute the fluid and remove it. This can even happen when working by hand – if there is a little grease on the hands the fluid will disappear. It only does so very slowly but if the work is to be hanging around for a long while and have many different operations carried out on it, then the marking fluid will go. In many cases operations will be finished long before this happens and so no harm is done.

Copper Sulphate

Where operations are to be extended, a more permanent solution is a better idea. Many years ago, before the marking fluids were ever thought of, engineers used copper sulphate for the job. Copper sulphate is permanent and is still used today in many instances. There is no reason why it should not be used in the model engineer's workshop. Simply get some copper sulphate crystals from the

chemist, dissolve about three teaspoonsful in half a jam jar (1 lb size) of water and you have the marking fluid. There is a snag of course, but then there always is!

Whilst a quick wipe over with a rag will suffice for the commercial marking fluids to adhere to the metal, copper sulphate actually changes the surface colour, so the metal must be perfectly clean in order to use it. Preferably, a rub with fine emery paper as well as cleaning with a rag is required. If this cannot be done, then use a solvent such as cellulose thinners to clean the metal. When it is clean, simply brush plenty of the liquid onto the metal and leave it for about ten minutes. It will change to a copper colour, and any surplus can be wiped away. The colour will be even and permanent, only being removable with a fine abrasive. Scribing marks will show up clearly through it.

Felt-tipped pens

For small areas where permanence is not an essential, a felt-tipped pen can be used as a marking agent. Rather than trying to wipe it on, use a stippling effect. The colour will be good, but will rub off with finger pressure as well as with a solvent. Nevertheless, it can be very useful for small work, where using the large brush or spraycan of the normal marking fluid is not convenient. (N.b. Use only a spirit based pen – the water based type are no good for this work.)



Setting a scribe against a ruler in a combination set.

Marking brass and copper

Where brass and copper is concerned, it is usually possible to mark out straight on the metal. They take little time to get some discolouration when exposed to air, and the scriber will show up fresh, clean marks which are clearly visible. Aluminium can often be treated in the same way; if it has been polished, however, a marking fluid will be required. Copper sulphate does not work in this case.

The scriber

Most of our marking will be done with a scriber as already suggested. Scribes can be purchased, but there is much to be said for making one's own to suit one's own requirements. They are easy enough to make and merely need to be hardened and tempered after the point has been fashioned. Should a scriber ever need sharpening, then doing so on a grindstone is not the best of practices. Far better to use a piece of emery cloth laid face up on a flat surface, and rub the scriber lengthways, whilst slowly rotating at the same time. The same goes for the sharpening of divider points, odd leg calipers, etc.

Datums

Having briefly looked at some of the tools required, let us now look at the way to set about things. In the last issue datums were discussed, an article which, of necessity, spilled over towards marking out. Datums are essential and before attempting to mark out any metal, the drawings should be thoroughly examined to establish suitable datum points. Assuming we have these, the most likely line to be needed is one running parallel with one of these datums. We can do this by using odd leg calipers or 'jennies', more properly called 'hermaphrodite calipers'. They consist of a



Setting dividers with a vernier caliper.

stepped caliper arm on one leg and a scriber on the other. Whilst they certainly have their uses, they cannot be regarded as one hundred per cent reliable as it only needs them to be at less than ninety degrees to the datum for the scribed line to be in the wrong place.

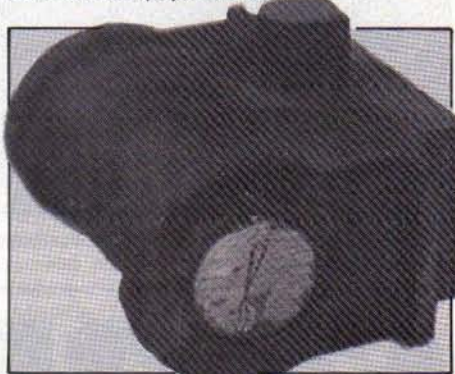
Using a scribing block

It is far better to use a scribing block, and to stand the work on its edge against an angle plate, running the scribing block along the surface plate in order to mark the metal. The scriber on the block should be carefully set to the required distance by reference to a rule held in an upright position. Do not rely on holding it freehand as, again, if it is not at exactly ninety degrees the measurement will not be true. Either support it on an angle plate or make a proper holder – a simple device consisting of a slot in a piece of suitable sized bar, with a small clamp to secure the rule. An alternative, if you have one, is to use a combination square, with the ruler in the upright position.

Scribing angles

Lines at ninety degrees can be made with the aid of a square, but angled lines can create problems. If a protractor or combination set is available then, with careful setting, these can be used to obtain the angle. Sometimes, however, it is not at all practical to get the correct angle with them, and marks must be constructed by measurement from the datum, subsequently being joined with a scribed line along a steel rule.

Talking of scribing lines along a steel rule, one reader wrote and asked how to prevent the ruler slipping as the line is scribed. Quite a good point and not so funny as it sounds if half way along the line the ruler slowly moves away. Blue-Tak is one answer to the problem. Tiny pieces on the underside of the ruler will give it sufficient grip whilst, at the same time, not raising it sufficiently to allow the scriber point to wander underneath. Another dodge is to stick a piece of paper underneath it at each end, using one of the adhesives such as Pritt which will easily rub off afterwards. The paper will prevent the ruler slipping, particularly if a coarse type such as newspaper is used.



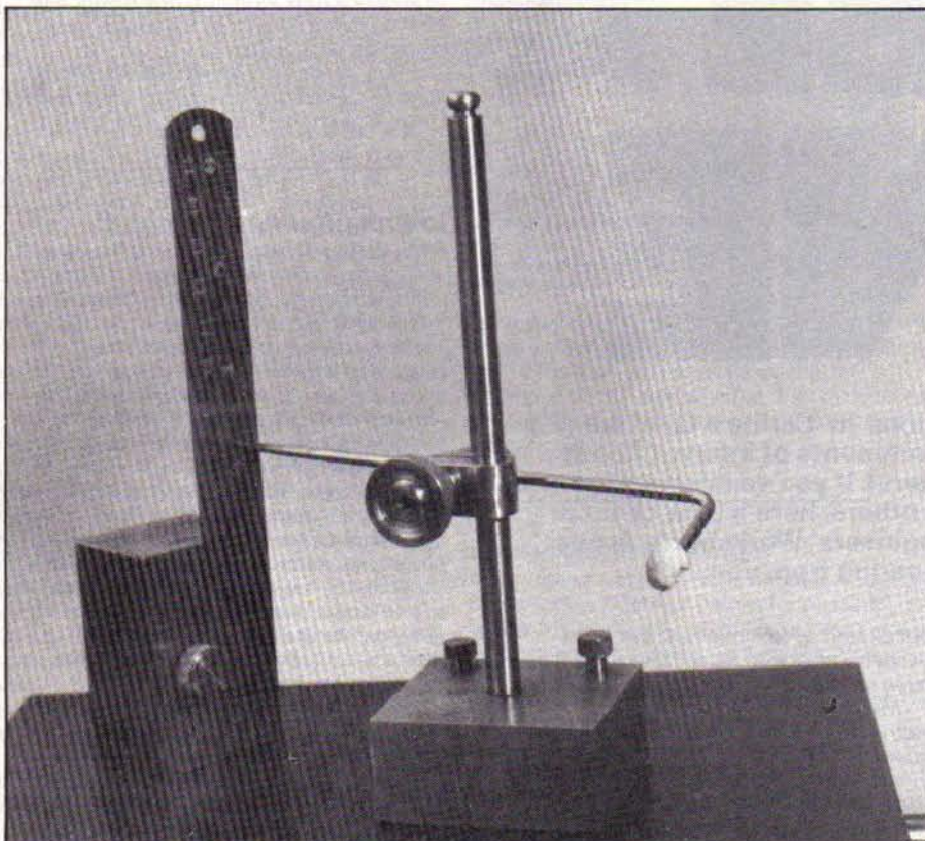
A cylinder casting where it would be necessary to mark out a bore. The hole has been plugged with wood to facilitate the operation.

Dot punching

It is a good idea to very lightly centre punch along scribed lines that are to be used as cutting lines; it is easier to see the tiny punch marks than it is to see the lines. If you do not have a suitable punch, then make one. A point of sixty degrees, or even sharper if the punch is to be kept for the one purpose, is needed. The punch should be very lightly tapped to ensure the marks are not too deep. Automatic centre punches can be useful for this sort of operation.

Dividers

Where curved marks are needed, dividers are used. Their use should need little description, save to say that the point



Setting a scriber against a ruler in a home-made holder, usually a far more accurate system than the combination set.

QUICK TIP

It is often necessary when making tools, etc., to form a square or hexagon on the end of a round bar. Assuming we know the across flats size of the square or hexagon it is easy to work out the bar diameter required. For a square, multiply the across flats size by 1.37, for a hexagon, multiply by 1.15.

that is to act as a pivot should always be placed in a mark made by a dot punch. Failure to do this will almost inevitably result in the static point slipping and the scribed arc or circle being wrong. It is very difficult to work on metal that has wrongly scribed marks on it and so if these can be avoided they should be.

So far, we have dealt almost entirely

with the actual marking of the metal; this is of no use if we are not accurate. Ideally a vernier height gauge should be used to make our basic marks. This is a gauge rather like a scribing block but with a vernier scale marked on it. This means that, assuming that one knows how to read a vernier, a high degree of accuracy can be obtained. Such gauges are very expensive

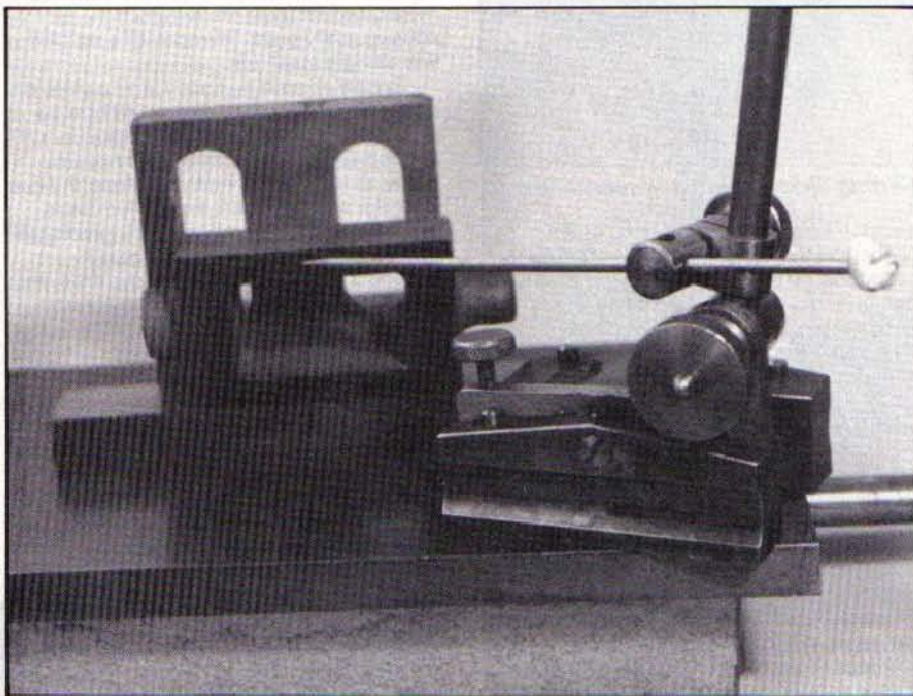
however and not everyone will have such a thing.

A good degree of accuracy can be obtained using a good quality ruler and a scribing block. Dividers set on a ruler can also give a high degree of accuracy, but do not use the edge of the rule, measure between marks. The edges of rulers are not always as accurate as they might be, and anyway the point of the dividers will inevitably drop lower at the end than it will be between marks. Odd leg calipers can also be set using a good quality ruler.

When centre punching use a fine pointed or dot punch first – it should be possible to feel the scribed line with this. Alternatively, and far better, make yourself an optical centre punch as described by Bluey in the first issue of *MEW*. Do not strike the punch hard but tap it gently applying more force when it is certain that it is in the correct position.

Care is the most important point in all marking-out operations. If it is possible to use a machine to help you, then do so. For example, if it is a case of drilling a row of holes and a milling machine is available, then use the graduation collars to space out the holes. If the machine will not take drills, it does not matter. Simply make a centre punch to fit in one of the collets and bring this down on the work. The mark made will be sufficient to enable it to be used as a basis for further indentation.

All marking-out tools should be treated with care and should not be left lying around the workshop when not in use. A square knocked off the bench, for example, will soon no longer be square. Other equipment can also be damaged in this way.



Marking out a steam chest with a scribing block; an angle plate is used to support the work.

SCRIBE A LINE

Your pages, your views and observations. In 'Scribe a Line' we give readers the opportunity to pass on comments of interest about previous issues and the hobby in general. If you've information or an idea you'd be prepared to pass on to others, here's your chance. Letters to 'Scribe a Line' at Model Engineers' Workshop's Argus House address. We look forward to hearing from you...

Help wanted

From Mr B. Butler of 73 St George Street, Romford RM1 2DT we have received the following query.

Can you find room in your magazine for my query? I have a Hilger and Watts 90 degree clinometer, type TB9008-1/189699 with a four inch bubble vial; the adjusting dial has two scales, 0-60 minutes with 30 second divisions. There are two quadrants, one is black, the other red. The fiducial lines were

out of step by 31.5 minutes, but this I believe was due to loose fittings, as it had been damaged before I acquired it.

My problem is how to read the instrument. I can use the type with one quadrant and one scale, but was the 31.5 minutes out of step built into my model as some form of vernier or not? If not, why two sets of scales and quadrants to do the same thing? Also, why colour one red and one black, what is the significance?

Rank, Taylor, Hobson (successors to

H & W) could, or would, not help other than to supply a new bubble. If any reader can help by direct contact or via your pages I would be very grateful.

If any reader has a five inch Challenger lathe in need of a screwcutting chart (brass) I have one spare. First come, first served!

Improvements on designs

From Stephen Vagg of Hastings we have also received a most constructive letter with many hints and tips, for which we thank him most sincerely.

I have read your magazine from the beginning and find it most interesting, with some very intriguing designs, and while I realise that to not only put pen to paper, but also to have drafted drawings and taken photographs of one's tool or machine, takes perhaps even more enthusiasm than the initial drive to make them, I should like to point out a few things that to another pair of manufacturing eyes seem obvious. I know that it is all too easy to become blind to one's own design errors. But above all, perhaps, encourage some people to produce something that they otherwise might not have bothered to.

Firstly the running centre; a marvellous sturdy design, but surely the washer retaining the inner races serves no useful purpose. As after all it can be assembled by placing the body down over the upright arbor then turned upside-down and held in the vice – who had a drop too much sherry and distorted the body? I'm not saying that the centre shouldn't have this washer and

screw fitted, just that it is an excess that is not required – after all as the author said he is all for making life easier. . .

Secondly the belt sander. I found the design of this most professional, but may I suggest a few mods that would make it easier to manufacture?

My first concerns the belt adjustment, which while functioning perfectly well is rather unnecessarily over engineered. My suggestion is to tap the holes of the tensioner shaft M8, the stud lengthened 25mm or preferably the brackets moved up 25mm towards the adjusting roller. After all, there is no need for them to be that far down. The M8 studding will be screwed directly into the adjusting roller shaft along with a drop of Loctite and a gentle tap with a hammer and centre punch at the rear as a belt and braces measure to stop rotation of the studding, adjustment of the roller is the same as before. Secondly, the slots milled in the shaft to prevent rotational movement are surplus, so the shaft can be turned to 17mm as before, but machine a groove 5mm wide down to 12mm diameter on the lathe. This retains axial rigidity but enables it to be made a lot easier (methinks it will work without using a groove). Might I also suggest that an economy model might be had by the utilisation of phosphor bronze bushes and circlips in lieu of ball-bearing races?

On the subject of stick welding (or MMA as it is in vogue to call it now!) might I be allowed to clarify a few points? On striking an arc, having seen apprentices over the years do exactly the same, I would assume mature folk not in the know would do the same. Don't podge the rod at the plate to start a new rod as this only raises the temperature of the operator with rage and not the job! Gently stroke with the rod (like lighting a match) from left to right (for right-handed persons) at about 30 degrees from the vertical. This should ensure an easy start up on a piece of scrap, then the rod can be easily started in the right place to weld the work. Might I suggest that it is only beginners that need to weave the rod to alleviate the possibility (probability?) of slag holes. Once one is proficient, i.e. no slag holes, then welding in a straight line is all that is needed. Slag holes are voids full of the melted flux that once covered the arc rod and are the result of bad positioning of the rod. To remedy, grind the area down, wire brush out any remaining slag and reweld. It will be found that any attempt to weld over slag holes without grinding out first will generally result in a new slag hole!

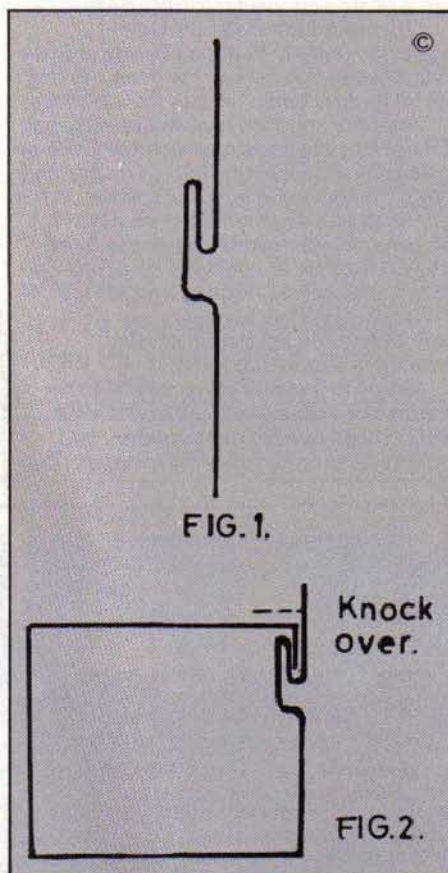
A bit of advice for the more experienced welder. Cast iron is fairly easy to weld but weld no more than 2 in. at a time and allow the casting to completely cool before the next 2 in. of weld. This will prevent the casting from cracking. Another way is to preheat the casting, complete the welding and allow to cool very slowly in hot sand or similar. Welding stainless steel, I would have to disagree with the author of the article in the Winter edition; it is just as easy to weld as mild steel, perhaps with less amps for the same thickness and, of course, with stainless steel rods.

I trust that these tips will be useful to fellow engineers and as the man said: "Practice makes perfect". May I end with:

She was only a welder's daughter
but she had a set o'lean legs (acetylene)
Penultimately with reference to Mr. J.K.

Widdowson's magnetic end mills, could it be that the bits are doing more rubbing than cutting i.e. either sharpened wrong or not rotating fast enough? A $\frac{1}{4}$ in. end/slot mill in HSS should be rotating in excess of 1500 rpm for mild steel. I know some people don't like using things rotating very fast, because of the popular misconception that it wears the tool out too quickly, whereas it is often the reverse that is true.

Lastly the Pittsburgh lock, as mentioned in the first issue (which sounds like a rather nasty wrestling hold!) is, as you say, a method of jointing sheet metal, and is still extensively used in the heating and ventilation industry. More commonly known as 'lock forming', done by machine (how else?), it is fed into the machine at one end and comes out at the other ready for



knocking over. See Fig. 1. Use? Mainly for square, straight sections of ducting Fig. 2. A handheld electric tool is available for folding over the locking edge, though not much in favour as it doesn't always work exceptionally well.

Low voltage lighting

Mr Lodge of Chesterfield is another reader to whom we offer our thanks for passing on the following very useful information for anyone making the low voltage electric lighting units.

I was able to buy the second magazine of your new production in W.H. Smiths in Cheltenham and was interested in the article on low voltage lighting.

I was already using a 21 watt car bulb in a home-made fitting on the end of a car map reading flexible but thought the 12v system would be an improvement. Being in Cheltenham, I was able to call at Wickes

and buy the necessary lamp before coming home.

After a fruitless search for the aluminium tube I was given a long length of a broken mast from a sailing dinghy which was of the correct dimensions. I was then able to buy suitable connectors for the lamp from Whistons Ltd., under Cat. No. 3909A at 10 for 65p with 10in of wire attached.

I have now finished the lamp and am highly satisfied but wonder if a ring of ventilation holes would be an advantage. . .

Speed reduction of machine tools

From Paul Norton of Taunton, Somerset, we have received the following, and are very grateful to him for his constructive comments.

I wish to thank **Model Engineers Workshop** and Mr. Haddon-Deering for the thought-provoking article, *Speed Reduction of Machine Tools*. There are, however, a couple of items which I wish to query. First, the feedback D5 and D6 have been incorrectly labelled as D1 and D2 in the diagram. They are the two diodes in series to the bottom left of the cluster of diodes for the field connections.

Second, this design has been made for supplies of either 110 or 240 volts and the link in series with R3 has been provided to adjust the triggering of the Triac on these voltages. A 110 volt series-wound motor of the type and quality of the one used so successfully by Mr. Haddon-Deering has probably survived on the 240 volt supply because a) it probably operates for short periods at maximum revolutions therefore at the maximum voltage and b) the current taken by a series-wound motor will largely depend upon the mechanical load placed upon the machine.

I am not sure, however, how long the shunt windings of a 110 volt motor would last on 240 volts with the circuit as drawn. Here the load taken by the shunt windings would be governed by their resistance and not the work the motor is doing. I can only assume that this circuit was intended to be used on 110 volts when using 110 volt shunt wound motor. Perhaps a similar control system to that used on the armature circuit could be used for the field windings and the variable control VR2 could then be adjusted so that normal operating voltage is not exceeded.

With D.C. shunt wound motors it is normal to reduce their armature voltage to reduce speed below the nominal rating of the motor. Speeds above the nominal rated speed may be achieved by REDUCING the voltage applied to the shunt field.

Therefore, a pair of controllers may be 'ganged' together so the armature has reduced voltage applied at low revs and the field has reduced voltage at high revs; the field voltage not being reduced until the armature voltage had reached maximum.

Many thanks for an excellent magazine.

Three-phase electricity

Geoff Bartlett, M.R.E.G., IscT, from Birmingham has kindly written to us at length on the subject of electricity and its uses in the home workshop, offering advice and help to readers on the subject.

Congratulations on a splendid magazine, the articles are really high class. Unfortunately, I feel a little worried as did C.D. Harrington over the electrical content, particularly the safety aspect.

No-one has less time than me for the HSE and some of the ludicrous regs which are spoiling our quality of life (and giving us ulcers, probably) but an HSE inspector reading this mag would probably throw a wobbly with some justification.

Taking the uncovered points in order, the corrected description of three-phase is still misleading. A three-phase supply box would contain three live wires plus an earth; it may or may not contain a neutral (maybe these days it always does).

Between neutral (if present) and or earth and any phase is an R.M.S. voltage of around 240 volts. Between any two phases the voltage is nearly twice this, root 3 times in fact, around 415 volts R.M.S. Neutral is normally very close to earth potential but could in a fault situation become somewhat live, so the wise man treats it with respect. Also neutral must never be connected to earth.

Mr. Brittain's hacksaw article is great but to describe a capacitor for motor starting as a round, cylindrical object is dicey! I can think of several round cylindrical objects which would make good shotgun cartridges in this application. These motor capacitors are a very special type and must be rated for the purpose – surely this should have been made clear. Also not carping, but a mains lead with a plug one end and insulated croc clips on the other is a lethal weapon. I know this is done and many a trainee has had a thick ear over it

happier working on a multikilovolt power supply!

I also use D.C. motors for toolpost mill drill, small high-speed drill, gearcutting machine, milling machine and machine hacksaw. With the exception of the hacksaw these are all low voltage. The mill is a third HP Sinclair C5 motor and the others are car heater blower motors, dirt cheap. The drill will put a 0.25 in. drill through mild steel of any thickness – the drill can penetrate almost as fast as my pillar drill. The hacksaw is 200 volt but the controller up to the thyristor is transformer isolated so as long as this doesn't fail I can work on it safely should a fault occur.

I hope my remarks are taken constructively; I must have had hundreds of but in an article (phew). The correct way is a safeblock or, as a poorer alternative, a piece of strip connector (CHOC BAR).

D.C. motors are excellent in the workshop and Mr. Haddon Dearing is to be congratulated on his work with same. The circuit for his controllers has the advantage of simplicity and I am sure works well and if it can be obtained properly boxed with no possibility of touching anything inside (and this includes having a plastic spindle on the speed control pot) then fine. I would not however advise anyone unless they really know what they are doing to construct one from the diagram (mistakes and all). It's OK if it works first time but if it needs faultfinding you have another lethal weapon in your hands.

I admit to a strong personal dislike for non-isolated controllers and to get me to work on one needs threats, bribery and various parts of my anatomy twisting. I feel

shocks in my working life and didn't like any of them!

Re magnetised cutters: this is only a theory but this is perhaps one of the things we notice but don't question until someone else brings it to light. I think it is due to stress in cutters or workpiece setting up eddy currents in the material, something like the reverse of magnetostriction where strong altering magnetic fields will produce minute dimensional changes in a ferrous material. If this theory has any merit, it would probably need a physicist to explain it...

Brine for quenching

On the question of the use of brine for quenching metal we have received the following interesting comments from Professor C.R. Tottle of Trowbridge.

With reference to the tip from Mr Stirling of Orpington on page 25 of the Winter issue of your journal, may I offer the following answer to the final question.

The efficiency of a quenching medium is partly dependent on the boiling point of the medium since high temperatures are generated at the surface of a heated component suddenly immersed in it. Bubbles tend to form on the surface, hence the agitation of the component to break them up.

Any solute added to water lowers the freezing point (hence the use of salt on icy roads) and raises the boiling point. Brine will therefore have a higher boiling point formation, with consequent improvement in the efficiency of the quench.

A DOT PUNCH

This is a useful little device which allows the operator to avoid some of the errors which occur when using an ordinary centre punch. It can either be used during marking lines, etc., for cutting, or it can be used to make a preliminary indentation for centre punching

done the job just as well.

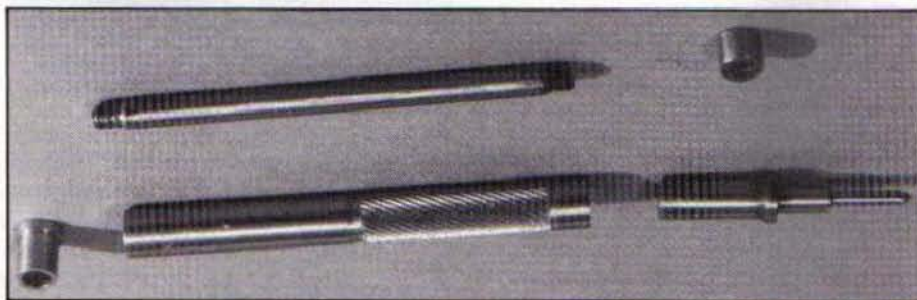
The point

The point was turned from silver steel and hardened and tempered. When everything else is complete this can be

The chapter on marking out refers to the use of a dot punch, or perhaps it should be called a marking out punch. This allows very fine indentations to be made along a line which has been previously scribed. These marks show up better than the scribed line, they are more durable and are a useful aid for machining, sawing, filing etc. It goes without saying that such marks must be made very accurately if they are to be of value. Whilst



A commercial plastic knob, bushed to accept the punch; a steel ball would add weight and be more efficient.



The parts for the centre punch; a delightful little exercise resulting in a really useful tool.

a centre punch with a steeper than usual point will do the job, the little tool described here is a more convenient tool to use.

The body

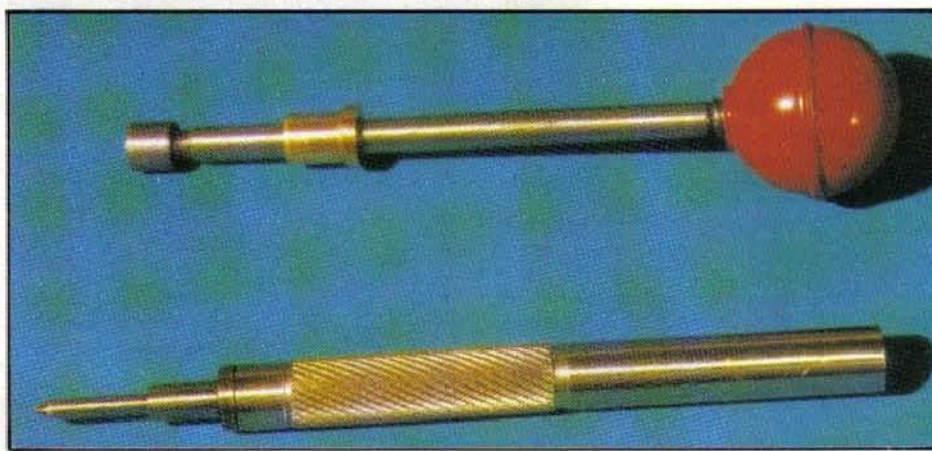
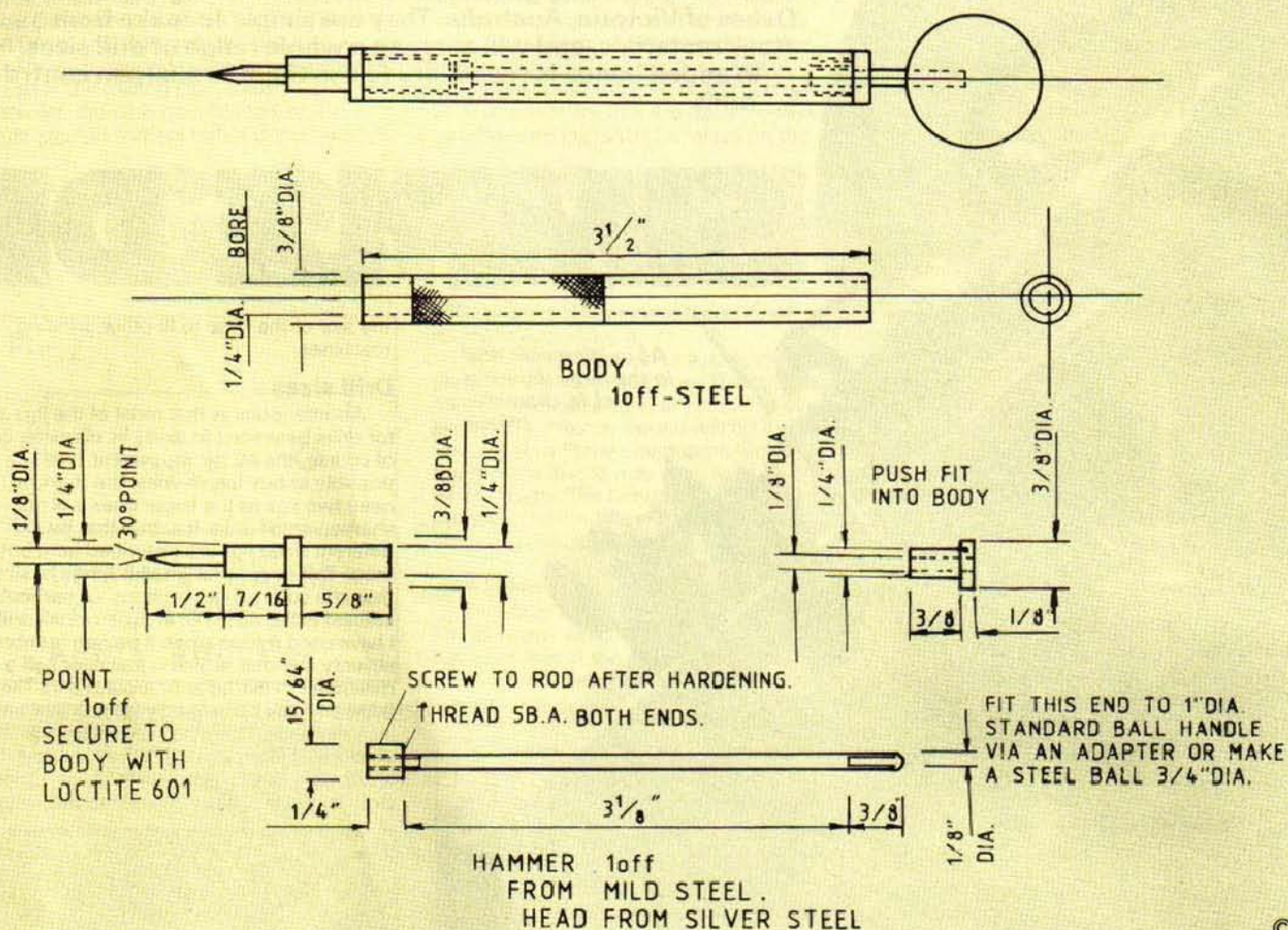
The body is simply a piece of tubing cut to length and machined square across the ends. The diameter of the tubing can vary according to what is easily available, and whilst steel was used, brass would have

fitted into the body with a retaining compound such as Loctite 601.

The hammer

The hammer is made in two parts, the rod which is simply threaded at each end, and the hammer itself which is a sliding fit in the tube and made from silver steel. It screws on the rod, and is hardened to prevent burrs being raised when it is used.

MARKING OUT PUNCH.



The punch partially assembled. Drawings above show how very simple it is to construct.

The collar

The collar was made from brass and again is very simple. It will need to be a tight push fit in the tube and some readers might like to make it tapered about a half a degree to improve this fit.

The knob shown is an ordinary plastic one as sold for machinery. The thread was too large and so a threaded bush was made to fit the rod. A steel ball would be

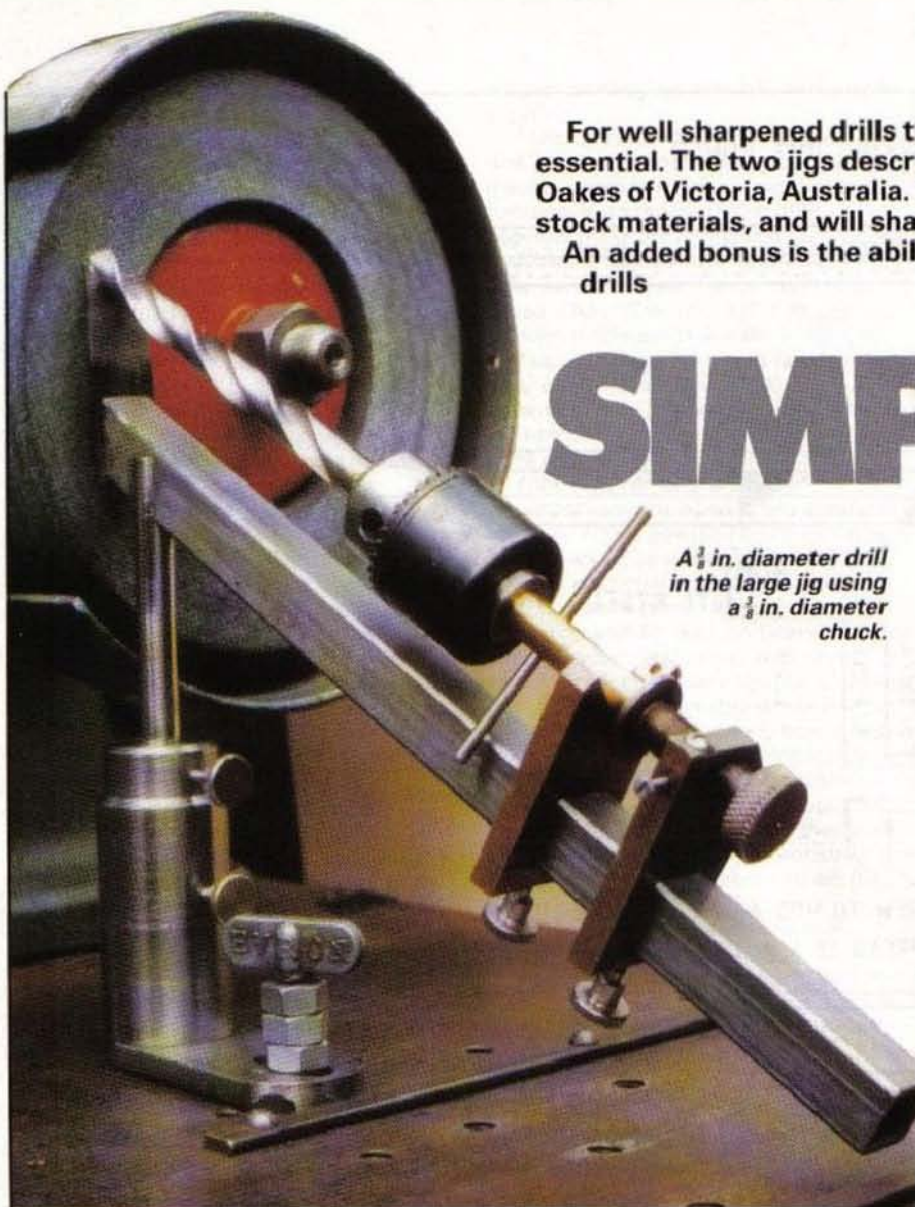
better as it would give more weight, and readers with capacity for ball turning will no doubt wish to make their own.

Using the punch

In use the punch can be used to actually scribe the line, left in position and the knob is lifted up and pushed smartly down leaving the required indentation. It really is that simple and so useful.



The completed tool; it can be used both to scribe the line and create its own indentation by lifting the knob then pushing it down firmly.



For well sharpened drills the use of a suitable drilling jig is essential. The two jigs described here were designed by Geoff Oakes of Victoria, Australia. They are simple to make from stock materials, and will sharpen a whole range of drill sizes. An added bonus is the ability to use them to sharpen centre drills

SIMPLE DRI

A $\frac{3}{8}$ in. diameter drill in the large jig using a $\frac{3}{8}$ in. diameter chuck.

the size of the base to fit other grinding machines.

Drill sizes

Another point is that most of the jigs are for drills between $\frac{1}{8}$ in. and $\frac{1}{2}$ in. diameter or, of course, the metric equivalent. It is possible to buy larger ones, but then we need two jigs as the larger ones will not sharpen small drills. It is true that two different sized jigs are described here but these two cover a far greater range of sizes than the commercial versions. Of particular interest is the ability to sharpen small drills; I have used it to sharpen a broken number seventy five drill, which is just over half a millimeter in diameter or around $\frac{1}{64}$ in. The large one has been used with a drill of an inch diameter. There have been several versions of sharpening jigs for the very small sizes in the past. These all use emery cloth as the sharpening medium but, whilst

Accurate grinding of drills is a difficult operation. A visit to a toolroom to watch an old experienced hand at work will reward the observer with an impressive display of skill and experience. He can, with a deft twist of his hand, grind the drill angle exactly as required without any difficulty. Newer recruits will resort to the drill grinding jig, something which the older hand never had access to during his apprenticeship, hence the need to develop his skill.

Even though many model engineers develop some degree of skill in the art of grinding drills, doing so by hand and eye is never a very satisfactory operation, and rarely will the end result be accurate. To ensure that a drill cuts even reasonably accurately, both cutting edges must be at the same angle and of equal length. Yes, it is possible to do this with larger drills, but try it with one of, say, a sixteenth of an inch diameter, and life becomes much more difficult. Below that, it is near impossible.

Grindstone heights

It is, of course, possible to purchase perfectly good drill grinding jigs, in which case, why should we bother to make them? Well, the ones purchased have a couple of disadvantages, apart from the fact that they cost money! Firstly, they all seem to be made for grinding machines with wheels of about eight inches diameter at least. Most model engineers, I should think, have to settle for five or six inch wheels. The result

is that, to use one of the commercial jigs, we need to raise the grindstone to the right height. This involves making not only a raising block but usually a baseboard as well, so the jig can be clamped or bolted to that. The measurements given for the jigs are for a grinder with a wheel centre height of $6\frac{1}{4}$ in. and using six inch diameter wheels. It may therefore be necessary to change

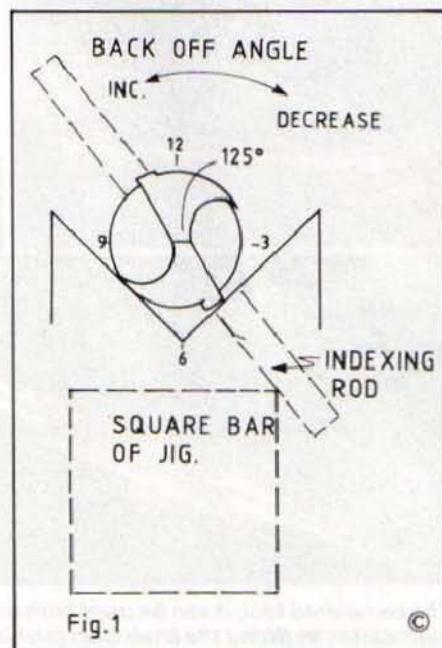


Fig.1



For cost cutting, the chucks can be dispensed with; here is a $\frac{5}{32}$ in. drill in a specially adapted version of item 11.

they do work, this is not the most satisfactory answer. A further bonus is the additional accessory which allows the sharpening of centre or Slocombe drills, something which certainly cannot be done in a commercial jig.

No special skills are required to make the jigs, and little description other than the drawings should be needed. I suspect that most of the material needed will be to hand in the model engineer's workshop, but an Eclipse pin chuck will be needed for the

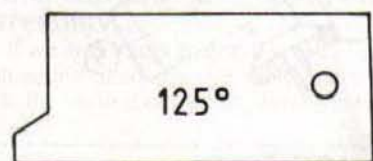
small jig, which I will call number one, and a drill chuck will be required for number two. This is specified as a Jacobs Multicraft chuck, which has a $\frac{3}{8}$ in. U.N.F. thread in the body. Other similar chucks such as Black and Decker can be used, the only modification needed being to use a suitable thread in the mating part. If cost is a deterrent, then it is possible to use the larger jig with carriers rather than chucks;

and tapped for the locking or anti-slack screw. This is shown as $\frac{1}{4}$ by 40 threads per inch, but can be of any convenient size. It is also shown as having a knurled head, but a cap screw or hexagon bolt would do as well. There is a plug between the screw and the post. This, in my case, was of wood, but a soft material of any sort would do. It is important that it is used, however, as otherwise burrs will be raised on the

capabilities might like to fabricate the body. Use $\frac{1}{4}$ in. $\times$ $\frac{1}{4}$ in. strip with $\frac{1}{4}$ in. $\times$ $\frac{1}{4}$ in. strip as a spacer. It can be screwed together and the screws Loctited into position to prevent their coming loose. Of course, if the body is made in this way, reasonable care must be taken to ensure it is nice and square. The end of the body is angled at sixty degrees, and the rounded slot must be cut for the pillar. This has to be at an angle in

ALL GRINDING JIGS

Fig.2



1/16" M.S. GAUGE
TO EXAMINE
ARRIS ANGLE.

©

pillar and it will become difficult if not impossible to move it.

The base is screwed to a mounting piece which was made from $1\frac{1}{4}$ in. $\times$ $\frac{1}{4}$ in. mild steel sheet. Again, any material of a suitable size that is around will do the job. The slot is to fit my equipment; those making the device may wish to use a different size. The temptation might be to just use a hole - this will not, however, allow any adjustment of the position.

The pillar

The pillar is ordinary mild steel rod of $\frac{1}{2}$ in. diameter which is cross-drilled at the top as shown in the drawings and tapped to accept the fixing screw.



The small jig and the common base.

these should be modified from the drawings to suit drill sizes to be sharpened.

The base

The base holding assembly is common to both jigs, and one can be made and transposed between each jig as required. It may be possible, if necessary, to make it shorter than shown, but a check would need to be made to ensure that the jig has sufficient clearance to swing. The lower part consists of a piece of $\frac{1}{2}$ in. diameter mild steel bar, bored centrally in the lathe for the pillar. It is cross-drilled near the top

The body

The body for number one is a piece of $\frac{3}{4}$ in. square bar. Milling the slot along the centre needs patience to avoid a broken cutter and will probably need the use of a long series end mill. Those who have horizontal milling machines might be able to do it with a narrow side and face cutter. An alternative for those who have vertical milling machines, or have no milling facilities, would be to use a slitting saw. Although the slot ends are shown as square they can be left rounded. Anyone who really thinks the slot beyond their



$\frac{1}{2}$ in. diameter drill in the large jig using item 11 as a holder.

order to get the cutting angle. It is shown as sixty degrees, which is quite satisfactory, but it should really be fifty nine if anyone has machinery that can get it that accurate. A suitable milling cutter taken in sideways with the bar clamped at the angle should do the job without any trouble. The two tapped holes in the end can be marked off from item one.

The drill support

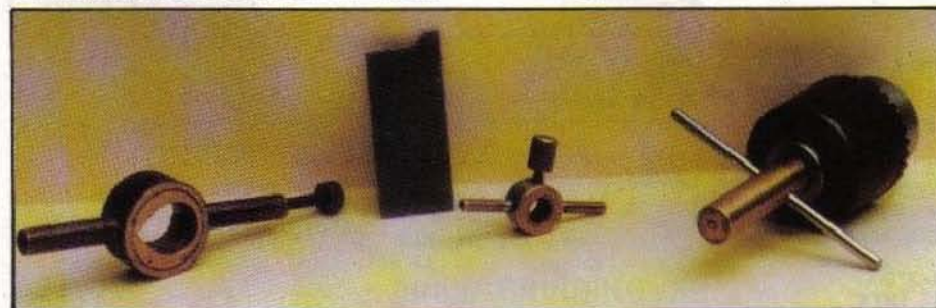
Part one is the actual drill support and, in the case of number one jig, was made from a piece of mild steel strip $1\frac{1}{2}$ $\times$ $\frac{1}{2}$ $\times$ $\frac{1}{16}$ in. The notch for the drill needs a ninety degrees angle and should be chamfered at the rear to allow very small drills to be supported by the front edge only. Because it is to be used with very small drills the left hand edge is rounded off to give better access to the grindstone. The two securing holes have already been referred to and should be used as a guide for the tapped holes in the body. Upon completion, the component should be case hardened as it will take considerable wear.

Drill holder support

The drill holder support (part two) can be made from mild steel or brass and is straightforward enough not to need a description. In use it is adjusted on the body, using a knurled thumbscrew.

The back stop

The back stop allows adjustment of the



Parts 4, 7 and 11 together with a prepared $\frac{3}{8}$ in. capacity chuck.

drill chuck according to the length of the drill. It also acts as the means of getting the length of the cutting edges even. Again, construction is easy and straightforward. There is a locking screw to prevent the adjuster from unwinding during operations. This is shown as an ordinary screw, but a knurled thumbscrew could be used if one so desired for cosmetic purposes. Once again, a small wooden plug is used to allow the screw to nip up without damage to the adjusting screw. The adjusting screw has not been shown separately as it is self-explanatory, being just a $\frac{1}{8} \times 40$ screw with a knurled head. The thread is around an inch in length. It can be made of either mild steel or brass. To allow for fine adjustment graduation marks round the edge could be worth considering.

The carrier

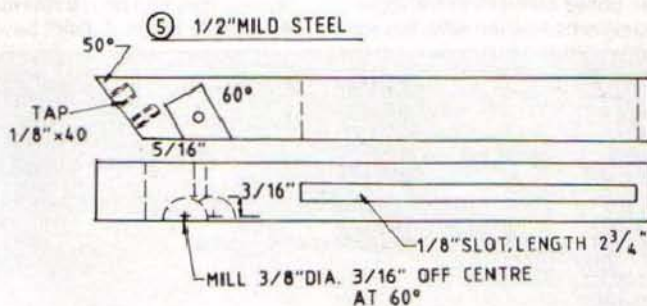
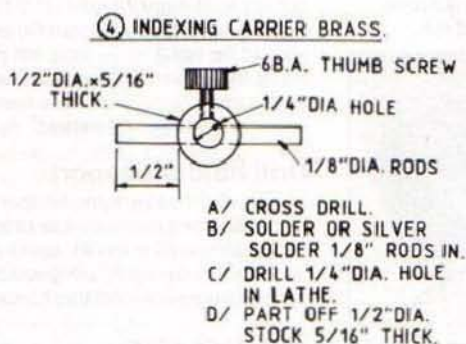
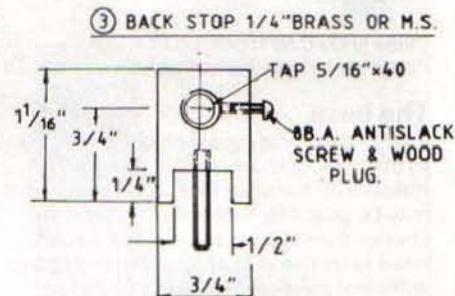
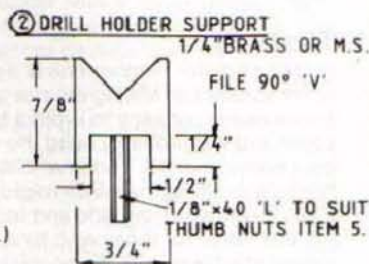
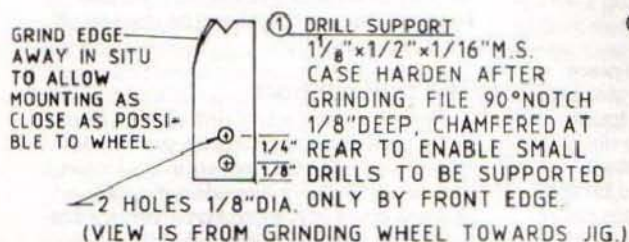
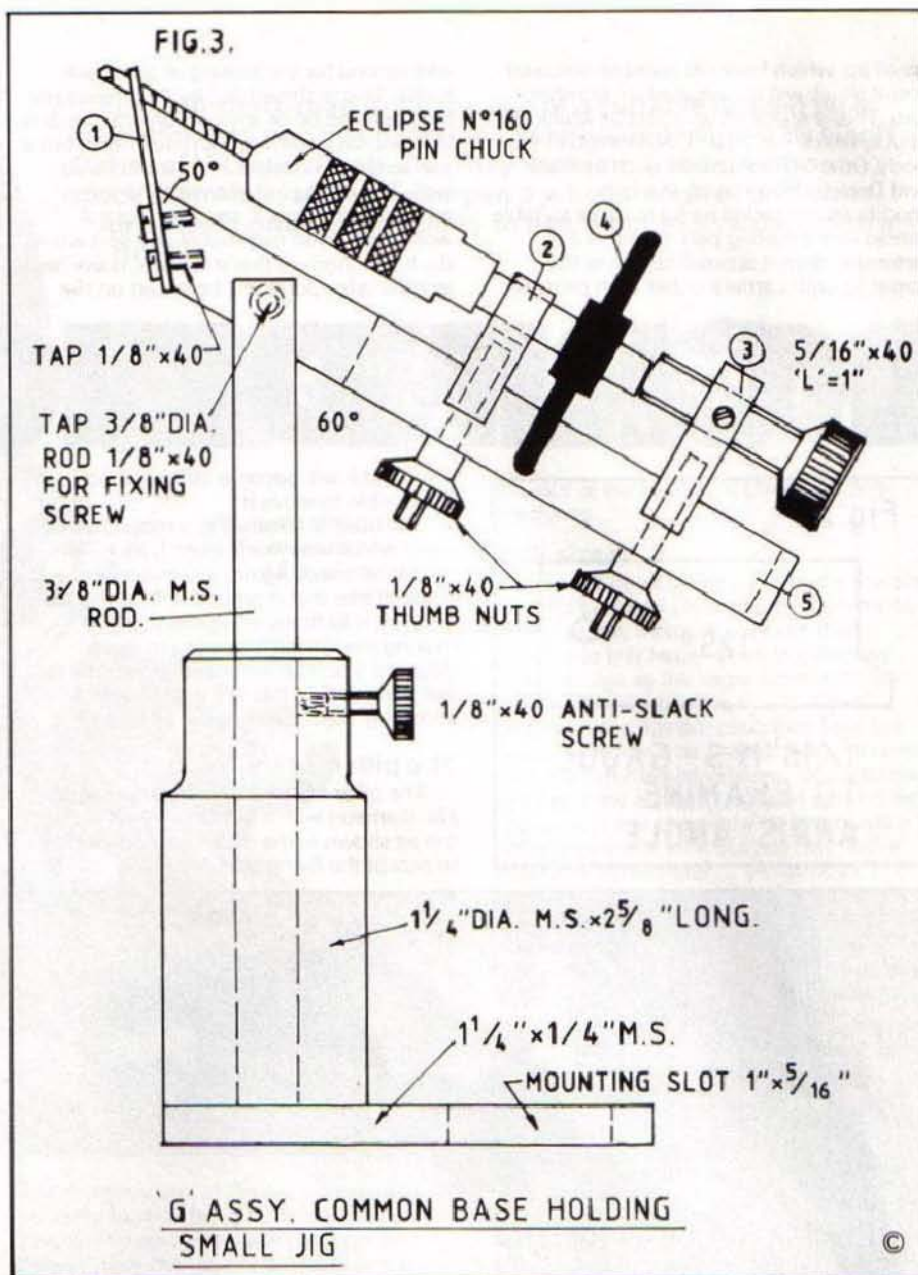
Part four is a carrier and it is this that gives the correct movement to the grinding operation. It is a mild steel fabrication. Reasonable care should be taken to ensure that the cross arms are central. The best format for construction is to cross-drill a piece of half inch diameter bar, and then silver solder the $\frac{1}{8}$ bar in place. Put the half inch bar in the lathe, and drill the $\frac{1}{2}$ in. hole. Then part off $\frac{5}{16}$ in. thick.

That about sums up the manufacture of the small jig.

The large jig

This follows closely on the lines of the small jig and little description should be needed for its construction. The parts on the drawing are numbered in sequence to the small jig and part six is the drill support. This takes a similar form to the support on number one, but there is no need to back off the vee and no need to remove the left hand side. Like number one, it should be case-hardened because of the wear that is involved.

The body (part ten) is similar to jig one, but has no slot, and it would be an advantage to make it from $\frac{1}{2}$ in. square steel, although $\frac{1}{2}$ in. will do if that is all that is available.



Indexing spindle

The indexing device is part of the chuck support rod, which makes life even easier. Simply thread the end to suit the chuck and cross-drill for the bar. Some chucks will have a male thread and there is no reason why these should not be incorporated in the jig. It might even be an idea to have a couple of chucks made up for different purposes.

Drill holder and back stop

The drill holder and back stop are both specified as from brass sheet. There is no reason why they should not be of mild steel, but it is easier to file the squares in brass. Both are secured to the body when lined up with knurled finger screws.

Other carriers - extending the versatility

If we are to stick to grinding drills up to half an inch diameter that really is all there is to the making of the jigs. Two further

carriers are drawn for the benefit of readers. Number eleven takes drills above $\frac{3}{8}$ in. diameter, and whilst sizes are given there is no reason why these should not be increased for the sharpening of larger drills. The drills are held in the carrier by a long thumbscrew which passes through one indexing rod.

The best method of construction is to drill and counterbore the $\frac{1}{4}$ in. diameter rod first to take the securing screw. Next cross-drill the large diameter rod and silver solder in the indexing bar. Put the large diameter rod in the lathe and drill the central hole, then part the material off. Finally, file the vee shape.

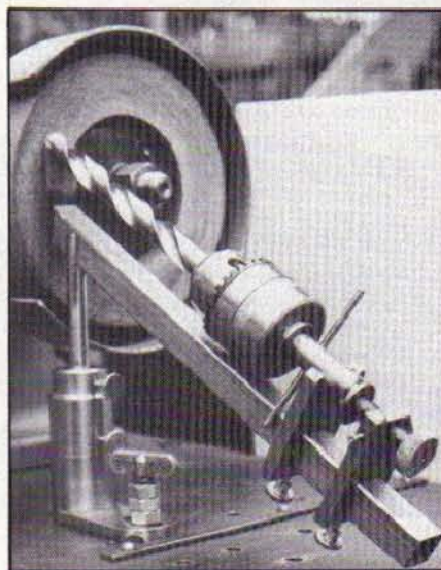
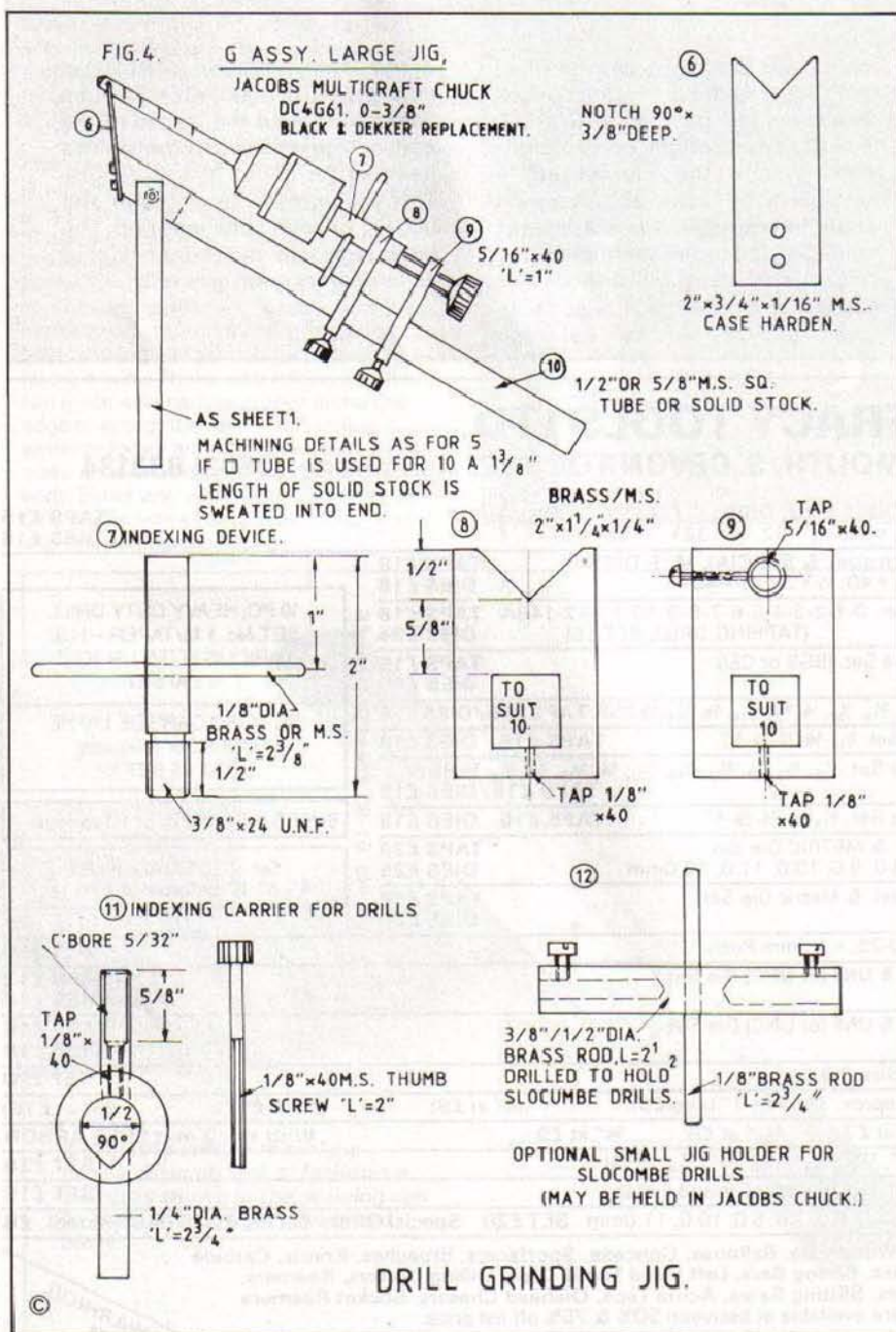
Slocumbe drills

Part twelve is designed for the sharpening of centre or Slocumbe drills. As described it will only accept the smaller sizes, but this can be very useful. The construction should not need any description. Whilst it is designed to be used

as an independent accessory it can also be used in the Jacobs chuck if one so wishes. Of course, in that case, the screw at the end not in use will have to be removed in order to get it into the chuck.

Using the jigs

The photographs give some idea of how to use the jigs. Reasonably accurate lining-up of the drills is essential. For very small drills it may be necessary to use a magnifying glass for this operation. With the drill resting in the vee notch and the indexing rod resting on the corner of the jig body the cutting edges of the drill should be in line with the centre line of the indexing rods, showing a position of five minutes to five o'clock. The set-up can be



A 1/2 in. capacity chuck in use on the large jig.

seen in figure one. This will give an aris angle of about one hundred and twenty five degrees corresponding to a back off of approximately ten degrees.

Jig number one is used with the pin chuck for drills of 0 to $\frac{3}{32}$ in. or numbers eighty to sixty eight, this is 0.3 to around 0.8mm. The second collet takes drills from $\frac{3}{32}$ to $\frac{1}{16}$ in. or number 68 to 53 in. gauge and 0.8 to 1.6mm. The largest size $\frac{1}{16}$ in. to $\frac{3}{32}$ in. or, numerically, 53 to 42 1.6 to 2.4mm.

The Jacobs chuck on jig number two takes drills from $\frac{3}{32}$ in. to $\frac{1}{4}$ in. or 2.4 to 8.5mm. Larger drills than this are sharpened on jig two using item number eleven.

Jig positioning

When using the small jig it should be positioned as close as possible to the grindstone - the smaller the drill the more there is a tendency for it to whip. If possible, the back of the grindstone should be used with small drills as this prevents their digging in. It may not be practical in all cases.

A quarter of a turn on the back stop screw pushes the drill forward 0.006 in. which is all that should be removed anyway. If a lot of work is to be done with very small drills, then it might be an idea to index the screw so that the exact position can be found and possibly a smaller advance made by turning the adjuster one eighth of a turn.

Where drills of over about $\frac{1}{4}$ in. diameter are being sharpened the front half of the



Small jig with a No. 58 drill being sharpened on the rear half of the wheel.

wheel must be used, otherwise there is a tendency for the drill to climb out of the vee. The downward pressure will keep it in place.

Small errors when dealing with tiny drills can be quite critical, so ensure that the anti-slip screw in the base is tight before grinding. It is also advisable to screw both grindstone and jigs to a steel plate to prevent any vibration that will cause them to move. Wood, even if it is hard, is not sufficient to prevent such movement.

A small gauge as shown in figure two should be made in order to check the aris angle; this can be simply filed from $\frac{1}{4}$ in. mild steel strip.

With the jigs made up, drills can be kept permanently sharpened and ready for use and there is a great deal of time-saving. If they get very badly worn it is extremely difficult to get them back into good condition whilst, if regular attention is given, there is absolutely no problem whatever.



Sharpening a centre drill using item 12 in the small jig.

QUICK TIP

No matter how much care is taken, threads will, from time to time, be stripped, either when tapping, or when tightening a bolt. The only permanent way to deal with the matter is to fill the hole, redrill and retap using, if possible, a smaller sized drill than previously in order to get a better percentage of thread. Filling the hole can be done in a number of ways. In metal such as

brass and bronze, it can be filled with silver solder or brazing spelter. The same can be done with steel, but the result might be unsightly. Drilling out the thread to a considerably larger size, tapping the hole, and filling it with a piece of threaded rod of the same material, which can then be drilled and tapped to the original size, is as good a way as any. For less

permanent repairs in an emergency, it is possible to wrap wire wool round the thread of the bolt, or to just flatten the bolt with a hammer for about half its length. This will spread the diameter and usually provide sufficient grip. The latter two ideas must be considered as temporary measures only!

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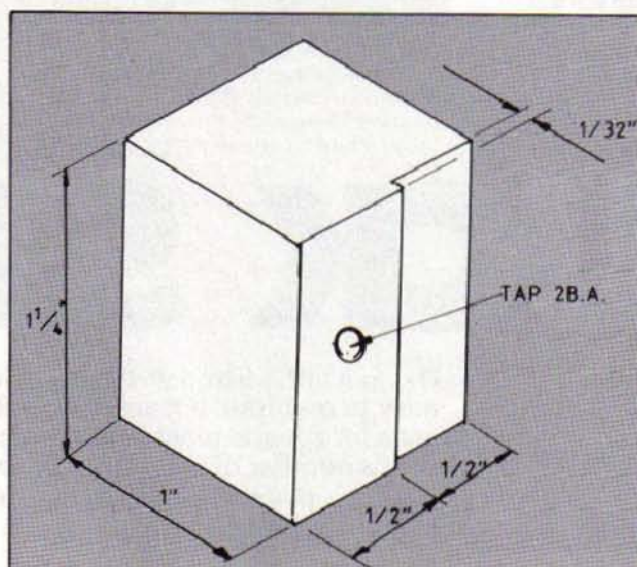
A RULE HOLDER

Readers who are new to the hobby will probably not have come across a holder for setting a rule vertical. Almost essential for good marking out, the device is simple to make requiring in its most basic form the drilling and tapping of a hole and a few minutes' filing only....

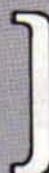
The advantages of setting a scribing block against a vertically held ruler have already been stressed, both when referring to marking out and when describing the manufacture and use of a scribing block. Those who possess combination sets may be able to use those for the purpose, although some of the rulers that are included with the cheaper sets do not have very fine graduations on them. Making a holder is very simple and well worth the little time that is involved in so doing.

There are a couple of easy ways to make the holder. Both will involve a short length of metal bar about an inch square. If only a rectangular piece is available, so be it; the size is not important, all that is needed is a weight to hold the ruler in position.

The base of the bar must be machined perfectly square and this is best done in the lathe, putting it in the four-jaw chuck and facing across. Those with milling facilities can machine a narrow groove along one edge to accept the ruler - this makes it easier to locate and set. Those without can make up a small clamp with slightly curved ends. Either way will do the trick and the only work involved is to face the bar end and drill and tap a hole.

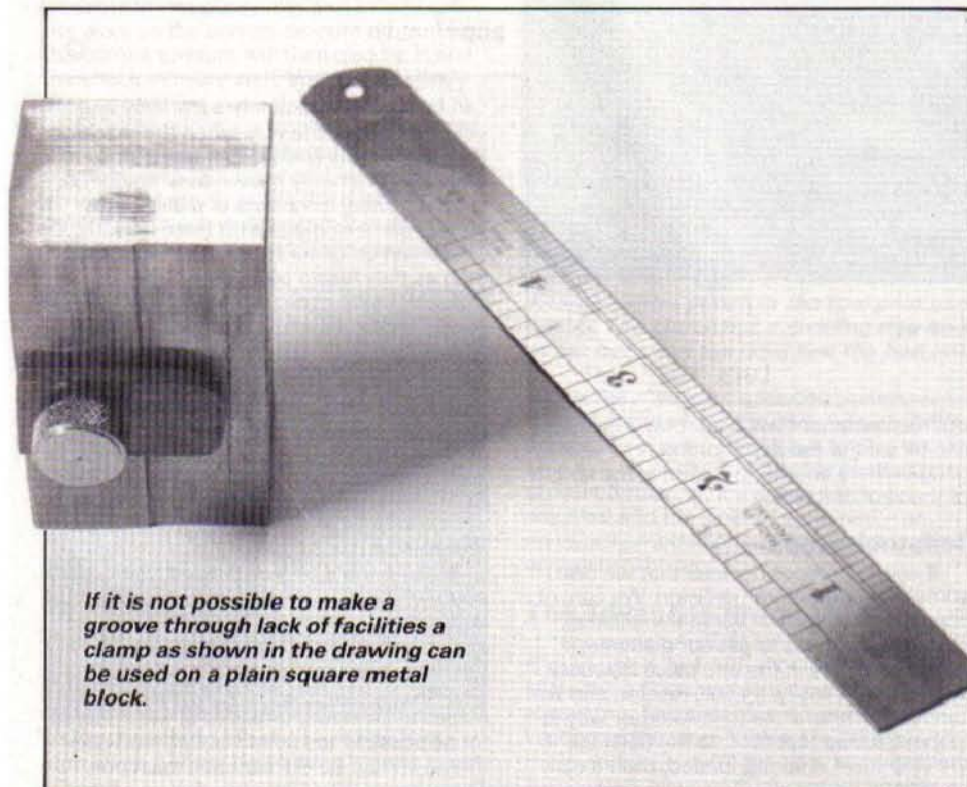


MARKING OUT RULE HOLDER.

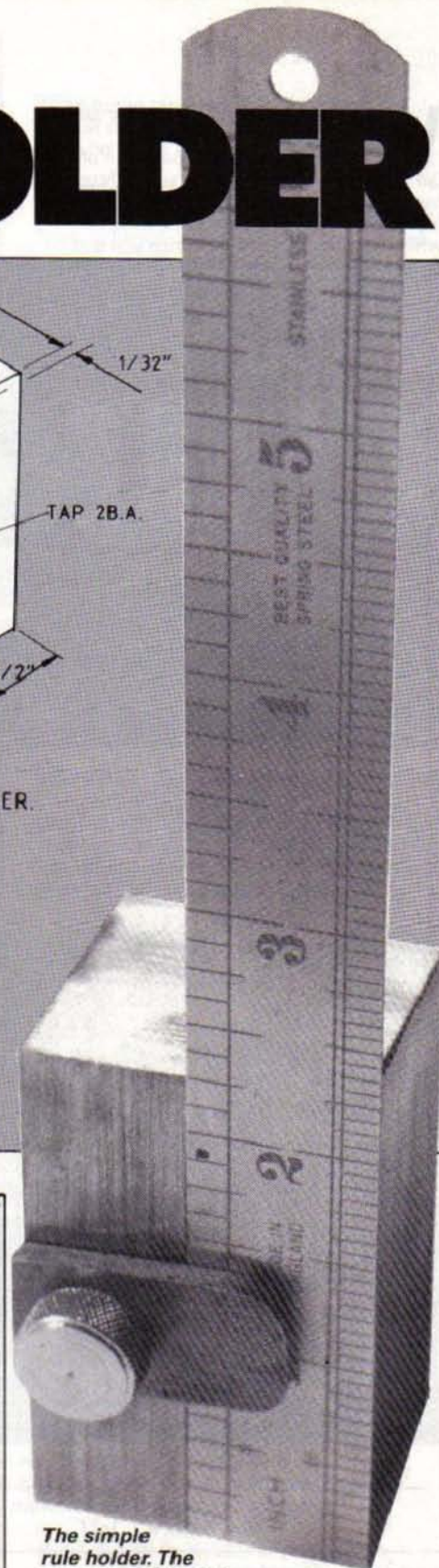


CLAMP

©



If it is not possible to make a groove through lack of facilities a clamp as shown in the drawing can be used on a plain square metal block.



The simple rule holder. The recess must be thin enough to allow the rule to stand proud.

When the holder is used, it is necessary to make sure that the end of the ruler is flush with the surface plate, as any angular movement will lead to a slightly wrong measurement. Where possible it is best to use it with the short ruler to prevent too much top overhang and therefore some lack of stability. Although its use on the surface plate is so far all that has been referred to, it can also be used for setting-up purposes on machines as well and, in fact, will frequently be found to have various uses in the workshop.



chuck. This is fine, but trying to read a ruler under these circumstances is far from easy and guaranteeing that two – let alone three or more – pieces of metal will be identical is not, to say the least, the easiest of tasks. One way round the problem is to use an ordinary depth gauge. Set the depth to the length we want, hold the prong against the chuck, and the work against the cross section and there it is. Again the system works and, for multiplicity, is better than the ruler. There is still the danger that the gauge might be at a slight angle and, if it is,

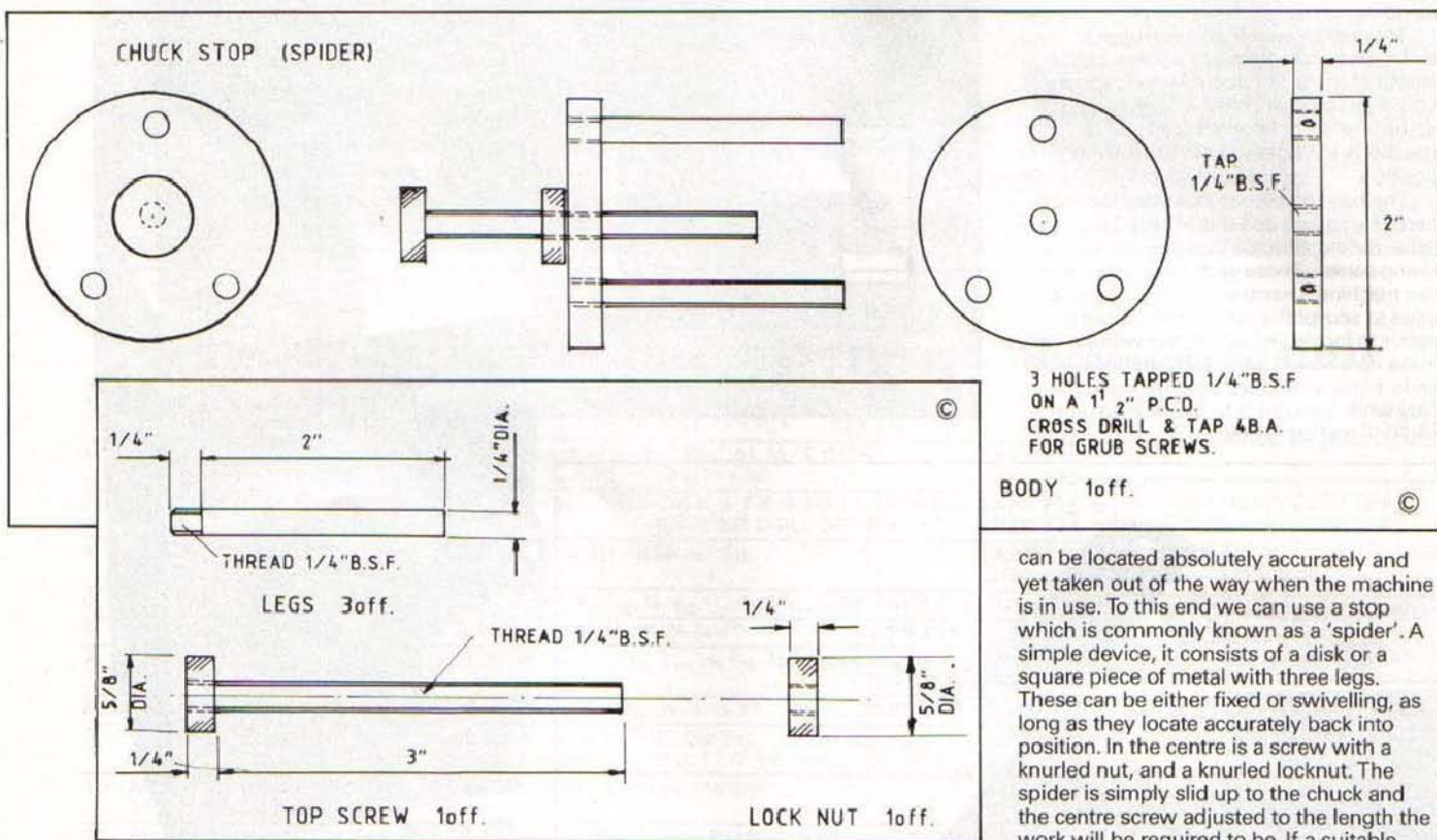
machining operations are carried out. Such stops do not leave a lot of room but they do leave some and can be quite useful. Useful, that is, providing we do not want to thread the work. If we do, then the tailstock die holder cannot be used without danger of moving the stop position when it is slipped back into the tailstock. An ordinary dieholder can be used but getting the thread square is difficult.

What we need is a simple device that

Use of chuck stops

There are various reasons for having chuck stops. As far as work protruding from the chuck is concerned, the obvious reason is in order to make two or more identical components. Suppose we want to make several components which are identical and which involve simply turning

Using a lathe fitted with stops on the carriage and cross slide it is easy to maintain accuracy to a shoulder or diameter. Often a job calls for several pieces of identical length, or one needs to ensure that a number of workpieces protrude exactly the same length from the chuck. This is where the chuck stops described here are invaluable.



a step on a piece of round bar. We can set the cross slide and carriage stops so that the same distance can be travelled by each of these. This should give us identical diameters and identical lengths of the large diameter. The length of section being machined down, however, is something of an unknown quantity. The amount it protrudes from the chuck will control its length.

We can, of course, put the metal in the chuck, take a rule and hold it against the chuck body, checking off the distance the metal protrudes and then tightening up the

our measurement will be wrong. The same can be said of the depth prong on a vernier gauge where another problem is the length of the vernier itself.

It soon becomes obvious that we need something with more precision. We can, of course, put a piece of bar in the tailstock chuck and use this to get our distance. It will have to stay in the one place however or we cannot easily, if at all, reset it, and we cannot machine close to it. Another way is to make a stop that fits into the tailstock. If the stop itself is spring loaded, then it can be slipped back a short distance while

can be located absolutely accurately and yet taken out of the way when the machine is in use. To this end we can use a stop which is commonly known as a 'spider'. A simple device, it consists of a disk or a square piece of metal with three legs. These can be either fixed or swivelling, as long as they locate accurately back into position. In the centre is a screw with a knurled nut, and a knurled locknut. The spider is simply slid up to the chuck and the centre screw adjusted to the length the work will be required to be. If a suitable thread is used, this can be calibrated and so used to get exact measurements. The work is located against the screw and the device taken away while machining is carried out.

Making the spider with fixed legs is easy enough. A disk is drilled centrally in the lathe, and tapped. Three holes for the legs are marked out and drilled and tapped. The tapped holes are cross-drilled and tapped for grub screws. The three legs are simply pieces of steel rod, threaded at the ends; as far as possible the length of both rod and thread should be the same on each one. These are screwed into the disk and the



The small components for the internal stop.

disk is then tested with a scribing block to ensure the legs are all level. When they are, the three grub screws are tightened up to lock them in position. Do not be tempted to make up the legs and secure them with retaining compound as it is essential that the stop be accurate and the use of retaining compound could result in one leg being a different length to the others. The



The finished stop.

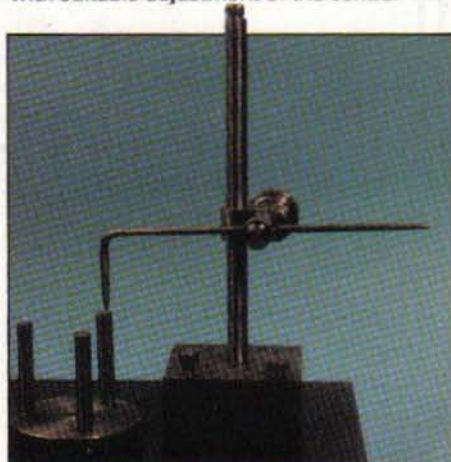
stop screw should need no explanation.

In use, the stop can either be placed against the jaws or the chuck body depending on the length of material with which it is being used.

Internal stop

On the other, hand we may have made several components and the need is to put them in a chuck at a set distance, in order to get the right machining length. It is possible to use our spider and simply set the work so the correct amount protrudes; the correct amount will then also be inside the chuck. All very well, but comparatively time consuming.

Quite frequently, a stop will be made by drilling a piece of bar tapered to fit the lathe mandrel, then tapping it and inserting a screw. The taper is put in the mandrel before the chuck is mounted; this allows, with suitable adjustment of the central



Using a scribing block to get the three legs level, before tightening up the grub screws.

fixed to the taper and locked against the rear of the mandrel. The adjustment can then be made through the tube.

Construction

Because lathes vary, measurements will have to be made to suit, but a pretty good



The stop before final assembly.

average is a lathe with a bore of around half an inch through the mandrel, so we will work on this, leaving others to modify as required. Simply make a Morse Taper to fit the lathe, and drill the narrow end, tapping it with a half inch thread. Drill nearly



A large centre punch in the tool post used for marking out the three holes on the spider. The chuck has a dividing ring on it, but it was quicker to just insert a piece of bar between the jaws and the bed and mark the component at each jaw.

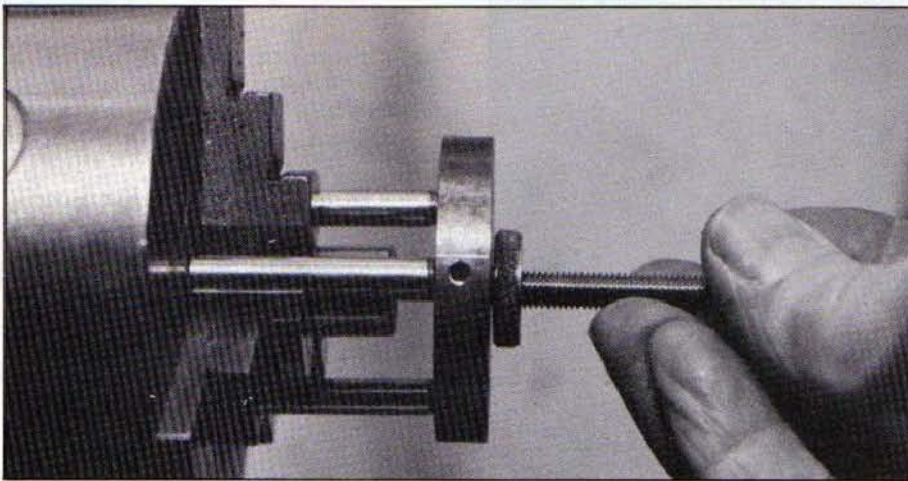
screw, the metal to be pushed up tight against it and so to fit an exact depth in the chuck. The system works but setting the stop can be fiddly. A locknut is needed to prevent it moving, the screw has to be adjusted and the locknut tightened – an awkward proposition as the locknut is right up against the taper.

The advanced form of stop

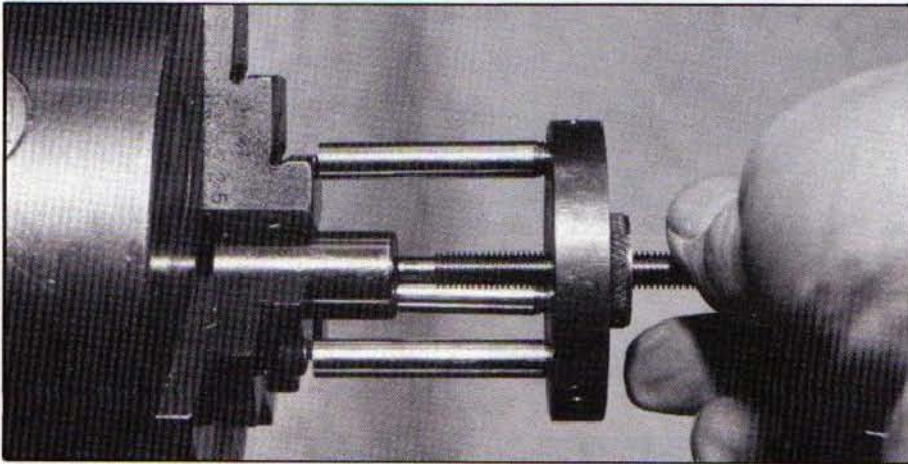
The basic principle being sound, we should use it, but with modifications that allow the adjustment to be made elsewhere. This means an improved version of the stop. Nothing too difficult to make and well worth the time and trouble involved. A piece of thick-walled tube is

through and finish with a quarter inch diameter drill. This last operation can be done from the blunt end rather than trying to pass a drill right through, which would need an extra-long series drill. The thread can be left to the individual; whilst it should be cut on the lathe, finishing with a tap is a good idea, and so whatever tap is available for a half inch diameter thread should be used. The finer the thread the better, in this case. Those working in metric will, of course, be using a twelve millimetre diameter tube.

Thread the outside of each end of the tube with the same thread. Here again, screwcutting operations are called for, but it is not a bad idea to finish with a die, if one



The stop used with the legs against the chuck body.



The stop used with the legs against the chuck jaws.

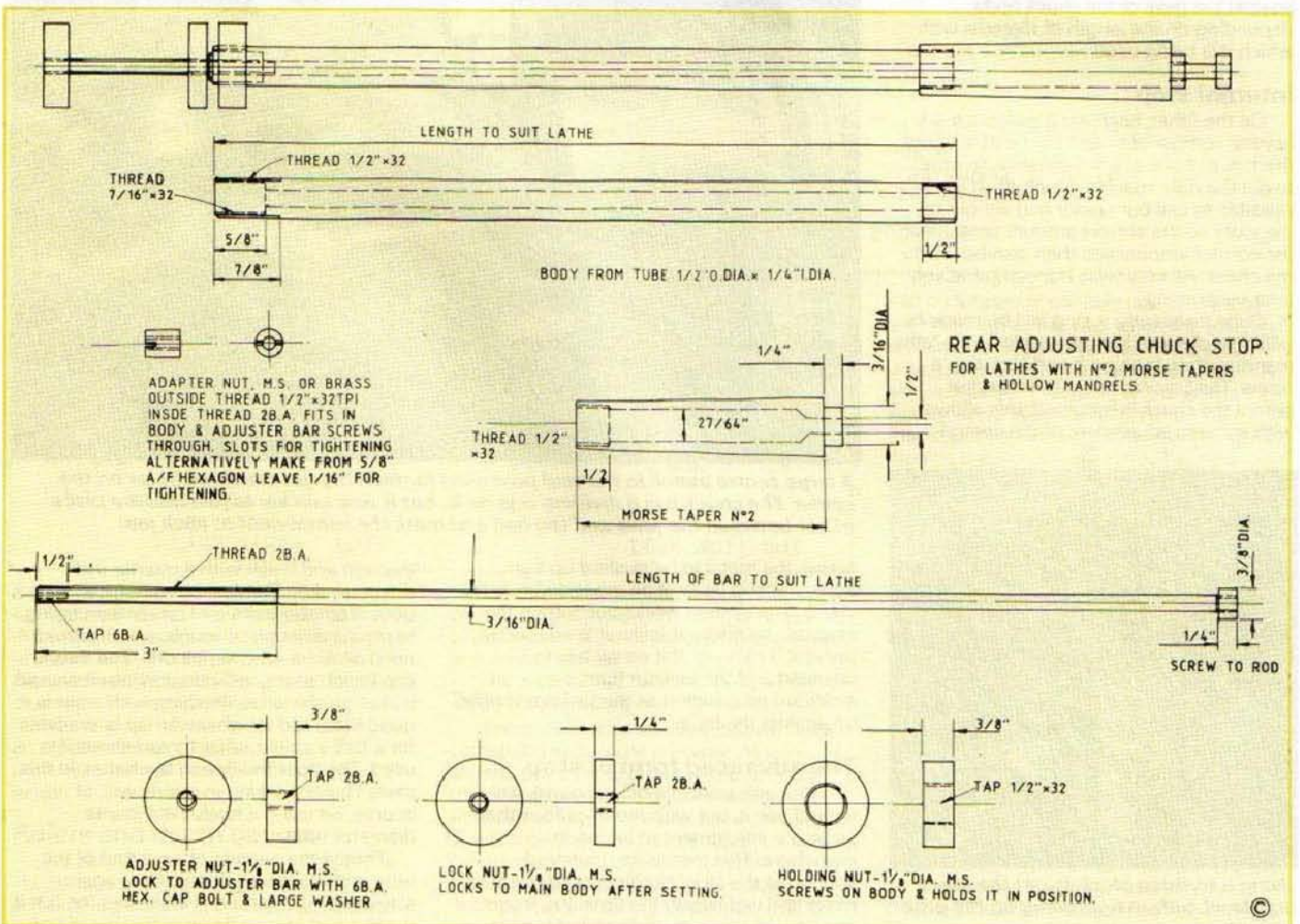
is available. A thread of about $\frac{1}{8}$ in. diameter is put on the inside at one end. An adapter is made from a piece of brass or steel which screws into the tube, and has an internal thread of a quarter inch diameter. This adapter can be slotted for a screwdriver in order to tighten it or can be from hexagon and a thin shoulder left for tightening purposes. A piece of rod is made up a $\frac{1}{4}$ in. diameter, threaded at one end to take the stop which screws on. The other end is threaded to match the adapter which fits inside the tube.

All that is now needed is three knurled nuts – one threaded to fit the outer thread of the tube, and the others threaded a quarter inch. The large diameter threaded one locks the tube in the lathe, one of the others is secured to the rod as the adjusting knob and the third one acts as a locknut after adjustments are made.

Using the stop

The stop is put in the lathe and is adjusted from the handle at the rear. To remove the adjuster, simply unscrew the stop itself. Further adjustments to length over and above those of the adjuster can be made by screwing the tube in and out of the Morse Taper; because it will be pulled up tight there is little chance of it unscrewing.

The adjustment being away from the chuck it can be made easily and without disturbing a piece of work that may have been inserted as a trial. As long as work is not going to pass through the mandrel, there is no reason why the stop cannot be left in position ready for use at all times.



A MICROMETER HOLDER

Micrometer holders are not as frequently found in the home workshop as one would wish. They can be very useful and are simple to make from scrap material. Measurements can be altered to suit material that is available, and the physical size of the micrometer.

Readers will probably be asking themselves, "why on earth should anyone want a micrometer stand?" An explanation must be the first thing. It is quite true that we use a micrometer in the normal way for measuring work on the lathe or the milling machine, and it is quite a successful operation, which can easily be carried out single-handed.

In this issue we deal, to a large extent, with marking-out processes. For this we will be using dividers in order to get greater accuracy than we can with a ruler. The dividers certainly help as long as we keep to figures such as sixty-fourths of an inch or half millimetres. When we need to be

All sorts of ploys can be used to prevent this movement, such as resting the elbows on the bench, or laying one's hands on it whilst holding the two tools. Experience shows that these are seldom very successful.

A stand for the micrometer means that we at least know which of the two tools is moving around, and it becomes much easier to stop it from doing so. There could be another good reason for making the stand. Micrometers are tools which like to play hide and seek. No matter where they were last put (and you are of course quite certain where that was), they still hide themselves behind all sorts of things. They

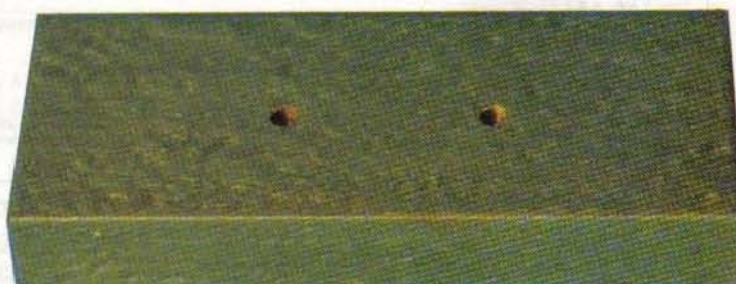
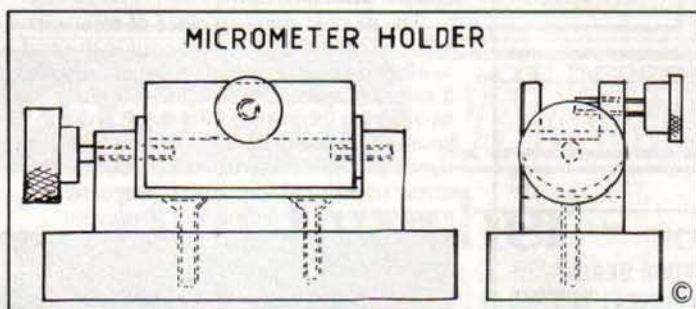
biggest problem and various ideas came to mind. Finally, it was decided that simple, accurate marking out was as good a method as any and it was done with the use of odd leg calipers. It was centre punched and checked again afterwards in case the punch had gone out of line. The holes were then started with a centre drill, after checking with a square that the work was upright in the machine vice.

There is no reason, if milling facilities are not available, why a piece of flat stock, say a quarter to five sixteenths of an inch thick, should not be used, and two pieces of the same material screwed to the ends for the uprights. Two 6 BA screws in each end will



Left: An overall view of the stand, complete with micrometer.

Below: The base. The holes are marked off from the swivel block.



more precise than that, the dividers must be set using either a vernier gauge or a micrometer.

Holding the dividers in one hand and the micrometer in the other and trying to just touch the points on the anvil without squeezing is no mean feat. Certainly the younger readers will manage quite well, providing they are not dabbling about after a heavy dinner supplemented with a couple of glasses of good wine. Older readers may well find that, even without the wine, the micrometer (or is it the dividers?) insist on moving! On the other hand, they may find that the wine has actually improved matters!



The swivel block. This one has been milled, but it could quite easily have been fabricated, by screwing the ends on.

are far less mobile when screwed firmly to a stand and as they are no longer lying flat are much easier to spot as they try to scurry away to the hiding place!

The base

The stand consists basically of three parts, all very simple to make, plus a couple of screws with knurled heads. The parts can be milled to shape if one requires or can be fabricated by screwing pieces together. Like most of our projects, sizes are only given as a very rough guide and any odds and ends of scrap metal can be used, in particular ends of flat bars can be pressed into service. The base as shown is a simple piece of bar stock. The ends can be filed square, although even this serves no useful purpose and is purely for appearance. The holes to accept the swivel block are marked off later through the block.

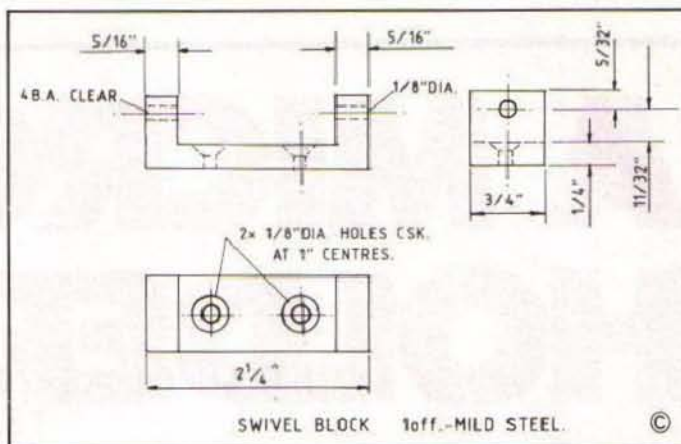
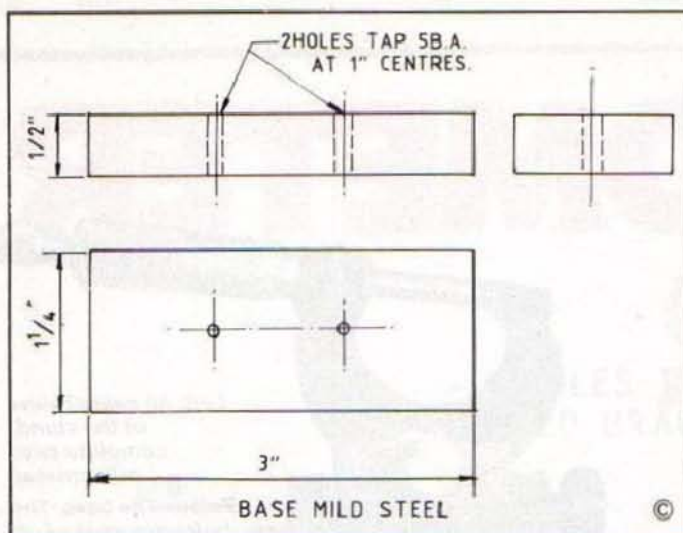
The swivel block

As shown, this was made from square material and milled to form the 'U' shape. Lining up the two holes in the ends was the

do the job quite nicely. The two holes, which are for the screws to hold it to the base, should be marked off and drilled, tapping size for the screws used. The piece can then either be clamped to the base with a small toolmaker's clamp, or secured with cyanoacrylic adhesive (superglue) while the holes are transferred. The ones on the swivel can be opened out to clearance size and countersunk, and those in the base tapped.

The holder

This can be milled from the solid or fabricated by screwing pieces together. The slot was not placed centrally, so that a better thread could be obtained for the holding screw. The hole or holes at the ends again can be problematic. Good marking out will suffice, but the work should be put in the lathe for drilling to ensure that it is parallel. Whether or not two short holes are made, one at each end, or a single one should be drilled right through is purely a matter for the individual. Certainly, if measurements are altered and the length of the holder shortened considerably, the hole can pass

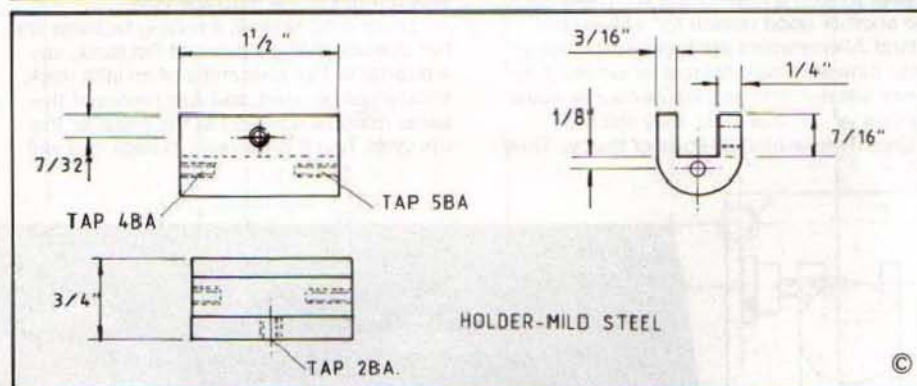
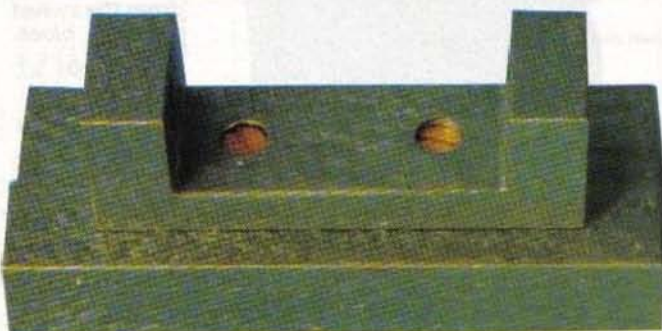


Left: The base and swivel block assembly.

Right: The holder; again this example has been milled but could have been a screwed construction.

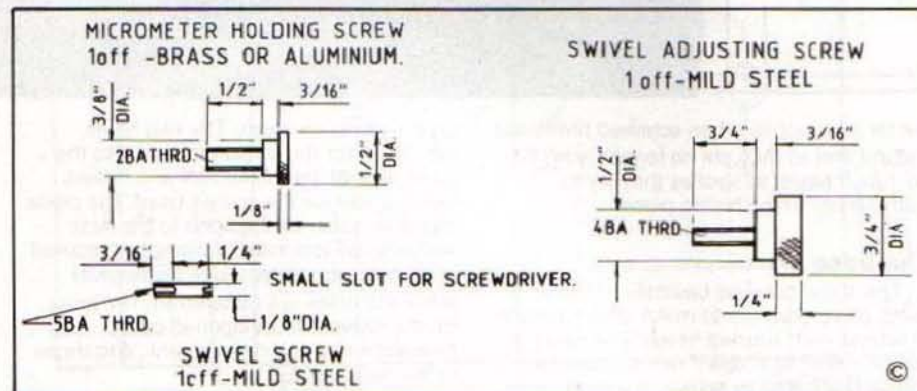
Below left: On the left the swivel screw. To the right the micrometer holding screw. At bottom swivel pin.

right through. As shown, one end is larger diameter than the other. This is to encourage laziness and save machining a piece of metal to 0.145 in. to make it fit the hole, it being easier to use a piece of $\frac{1}{8}$ and put on a 5 BA thread. Those using metric material and threads should have no such problems, 4mm doing for both thread and pivot. However, 5 BA is a little small for clamping up and so 4BA is specified. Finally, simply round off the bottom edges to give a good clearance as the micrometer is swung over.



Pivot and bolts

The pivot is simply a piece of steel with a thread on the end. A slot is cut in the end to allow a screwdriver to be used to tighten it as it is recessed in the holder. There are two screws, both straightforward enough; knurled heads are optional but do help with tightening up as well as looking better. The screw used for holding the micrometer must be brass or aluminium to prevent



damage to the micrometer. When the parts are assembled, washers are placed between the holder and the swivel block; this prevents the two parts rubbing and scratching each other.

And that's it. More scrap material has been used up instead of being wasted and a useful little tool is ours as a result!

QUICK TIP

When hacksawing large diameter or any large section metal, the hacksaw likes to go its own way. The result is a cut at an angle, which it can be difficult to face across, or may even result in the length of metal being undersized. Put some insulation tape around the metal at the place where the cut is to be. Saw along the edge, and keep rotating the metal in the vice so that the initial cut of about an eighth of an inch deep will go right round the edge. It is then possible to cut right across without the saw wandering off line.



AUCTION SALE

On Saturday April 20th, 1991, at 9.30am, Unit 1, Mantion Road, Rushden, Northants. Viewing Friday April 19th, 8.00am to 6.00pm and morning of sale from 7.00am throughout. Under instructions from five deceased persons model engineers workshops. Mr Blackburn of Coventry, Mr Stephenson of Liverpool, Mr Gent of Milton Keynes and Mr Payne of Worcester. Contents of Training College, P & T Joiners & Cabinet Makers and County Court. Colchester 2000 Lathe, Jones & Shipman Surface Grinder, Contents of Bankrupt Ironmongers, Contents of Two School Workshops. Twenty Pillar Drills, Five Hundred Sash Cramps, Power Hacksaw, Three Mig Welders Generator, Qty of Electric Power Tools, Multico Tenoner, Chisel Mortiser, Wadkin Planer Thicknesser, Spindle Moulder, Startrite Dimension Saw, Qty of Old Enamel Advertising Signs & Railway Signs, Qty of Various Steam Models, 1954 MG TF (Australian export Model), Myford Lathe, Milling Machine, Large Qty of Inspection Equipment. Six Woodturning Lathes, Thirty Bench Grinders, Edge Bander, Engine Hoist, Capstan Lathe, Wadkin Bandsaw, Startrite Bandsaw, Wadkin Mortiser, Four Compressors, Matchless Silver Hawk 1931 Motorcycle, Norton 750 Commando Motorcycle, Scott 1924 Motorcycle. Approx. 900 Lots. For auction catalogues, send stamped addressed envelope to Warner Auctions, 47 Allen Road, Irthlingborough, Northants. Persons wishing to enter any items into our forthcoming sales, please telephone Lisa Richardson on 0933 316812.

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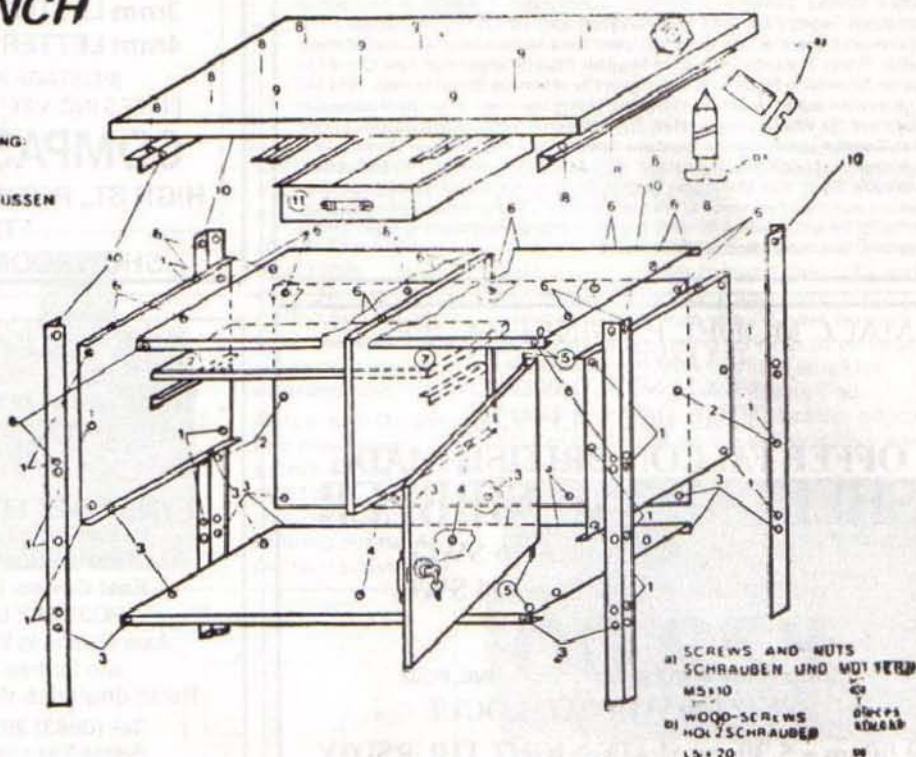
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- 4 MIDDLE-WALL
MITTELWAND 2 a)
- 5 DOOR
TÜR
- 6 UPPER-PLATE
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- 7 RACK
GESTELL
- 8 ANGLE-IRON WITH WOOD-PLATE
WINKEL-EISEN UND HOLZBLATT 8 b)
- 9 DRAWER-SLIDES
SCHUBLADEN-FÜHRUNGEN 6 b)
- 10 WOOD-PLATE WITH FEET
HOLZBLATT UND FÜßEN 4 b)
- 11 THE DRAWER
SCHUBLADE



For good hand work a sturdy bench is a must. A bench seen on the stand of Warren Machine Tools at this year's Model Engineer Exhibition created a great deal of interest amongst visitors. We were kindly allowed to test one and it proved to be a superb piece of equipment – the cost is amazingly low for such a rigid bench

There is no doubt that one of the essentials of a workshop is a good bench. Of course we hear tales of, or know, people who work on the kitchen table or a couple of boxes. Usually this is from necessity rather than from choice, and the majority make the bench a first priority. Usually it is home-made, from wood, and if one is wise the wood is bolted together. Some benches are made from steel angle or these days welded together from square section steel. Whatever the method of framing, the big problem invariably seems to come when trying to find a top.

Chipboard is not too bad, and old kitchen work-surfaces can provide a hefty piece covered with protective laminate. Whilst chipboard works quite well it is difficult to beat a really good piece of plywood. These days that costs the earth. Even 12mm thick ply is very expensive and anything thicker than that needs a mortgage!

It was with all this in mind that we were pleased to accept an offer to try out a bench being marketed by Warren Machine Tools. It came delivered as a flatpack, the packing itself providing some very useful thin plywood suitable for a variety of small

projects. The bench frame is made of bolt-together steel panels. Whilst these in themselves do not appear very substantial, the assembly was found, when completed, to be extremely strong.

Assembling the bench

Assembly was not all that difficult, taking around two hours. On the whole, it went together very well, although two holes had to be just eased to line them up to accept the bolts. This is quite a satisfactory situation, and it would be unfair to expect a more perfect fit than that.

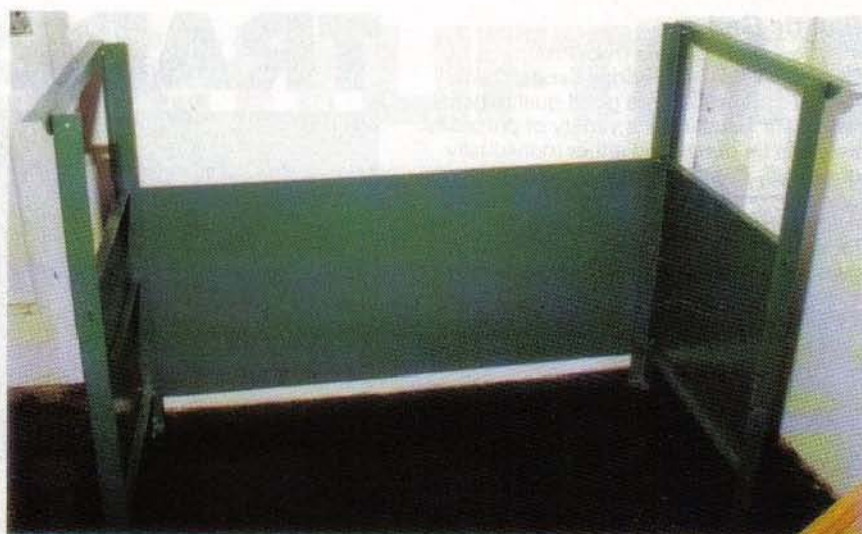
Instructions were quite adequate, being in the form of a plan. It does need a little study to see what goes where, and a little thought too. For example, stage one is putting on the side panels, stage two the top cross members and stage three the back. The back, though, is a much better fit if placed inside the side panels and a little thought will soon make one realise this, and not to charge ahead without thinking. Likewise, the floor should go inside the side panels for support rather than bolting it on the outside. These are just minor points which must be considered when

The assembly drawing as supplied with the bench; we have reduced it slightly here but, even so, the diagram will repay careful study.

assembling the bench, otherwise it is extremely simple.

The bench frame includes a shelf, a cupboard door with lock and keys, and a drawer, the latter being supported by runners screwed to the top. That brings us to the top which must be the best part of all. It is 40mm thick plywood, and hard ply at that. As the bench when complete is near enough four feet by two feet, that represents a very hefty chunk of material. It is screwed to the ends of the frame from below and, when complete, the bench is absolutely as rigid as it could be. The top will support the heaviest vice, and those who are more adventurous than others will no doubt be thinking of screwing angle along to make long piece vices etc. It is certainly rare to see a piece of material so suitable for supporting such equipment.

The cost of the bench at the time of writing is fifty eight pounds, plus VAT and this includes carriage – it must be the bargain of the decade. To buy the top alone would surely cost nearly that amount, if indeed one could obtain such a lovely piece of material. There is no doubt that it would cost more to make such a bench than it does to buy this one. It is obtainable from Warren Machine Tools, Warren Court, Middle Street, Shere, Surrey GU5 9HF, tel. 048 6413434 or their northern depot at Adlington Court, Risley Industrial Estate, Birchwood, Warrington WA3 6PL, tel. 0925 821616



Top left: Start with the sides and top rails. Do not fully tighten the bolts on the side plates at this stage. Top right: The fitting of the backplate is the next operation. Above centre right: The bottom, when fixed next, gives the entire structure strength. Ensure that the bottom plate is put inside the side plates, otherwise it will sag. Tools required for the job are a spanner, screwdriver and, for a couple of holes, a drill merely to ease them out. Above left: Now turn the assembly over. Above right: next fit the shelf and cupboard door; the hinges simply slip into the holes in the bottom and the shelf. Right: The completed Warco Workbench in all its glory! In this last photograph the robust top has been fitted with the wood screws supplied and the drawer is also shown in position. The result is an exceptionally strong bench that's not only simplicity itself to construct in a matter of moments but one which is a real bargain in these costly times.



Plastic Gears

These plastic gears from Proops Distributors Ltd, Heybridge Estate, Castle Road, London NW1 are good quality gears which are suitable for a variety of purposes. they can be purchased either individually or as sets. The range includes spurs, bevels, worms and racks, so just about every eventuality is covered. We used them for a simple dividing device, and to make a gearbox for the filing machine, with equal success. They cost only a fraction of the price one would normally expect to pay.

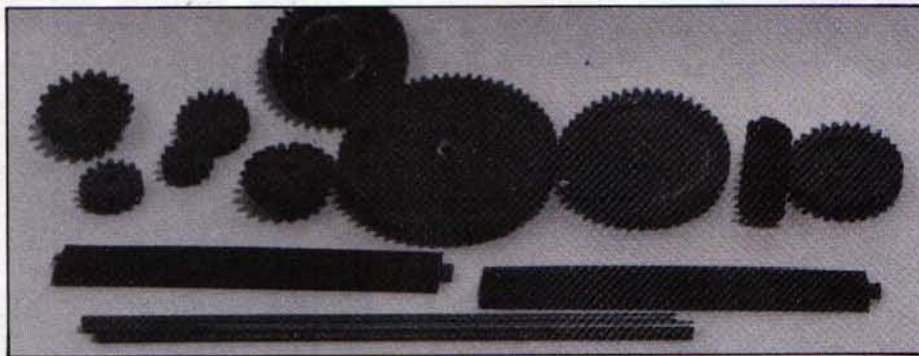
A small, powerful electric motor

This motor came from Peatol Machine Tools, WE, 19 Knightlow Road, Harborne, Birmingham B17 89S. It is actually a 110 volt D.C. motor but comes complete with on/off



control box, for use on 220 volts a.c. It is very powerful and yet is small enough to be used for the toolpost grinder and to drive the filing machine via a gearbox.

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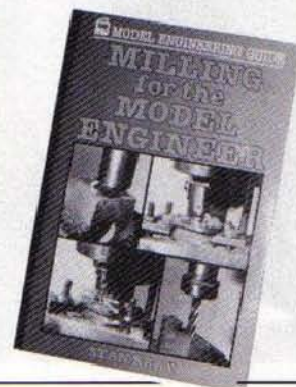


Under test it showed no signs of overheating after an extended run. The motor is priced at £15 plus postage and packing. As it is a surplus item, and in view of the low price, stocks will no doubt be limited.

Milling for the model engineer

No comment will be made on this book as it is written by the editor and it would not be fair to pass judgement! It is a full instruction manual on all aspects of using a milling machine, and covers the whole range of operations likely to be required by the model engineer. It is hardbacked and, for this reason, the price at £14.99 is rather higher than one would normally expect. The fact that it is in hardback form should, however, make it longer lasting than the more usual soft cover versions of workshop

books. It is published by Patrick Stephens Ltd, who are now part of the Haynes Publishing Group, well known for their range of vehicle workshop manuals and other transport and technical books.



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D.I.Y WEIGHTLIFTING

Mr C.J. Austen of Chislehurst in Kent found moving heavy workshop equipment difficult, as do most of us. Here he relates how he coped with the problem. His ideas may be of use to other readers who are having the same difficulties

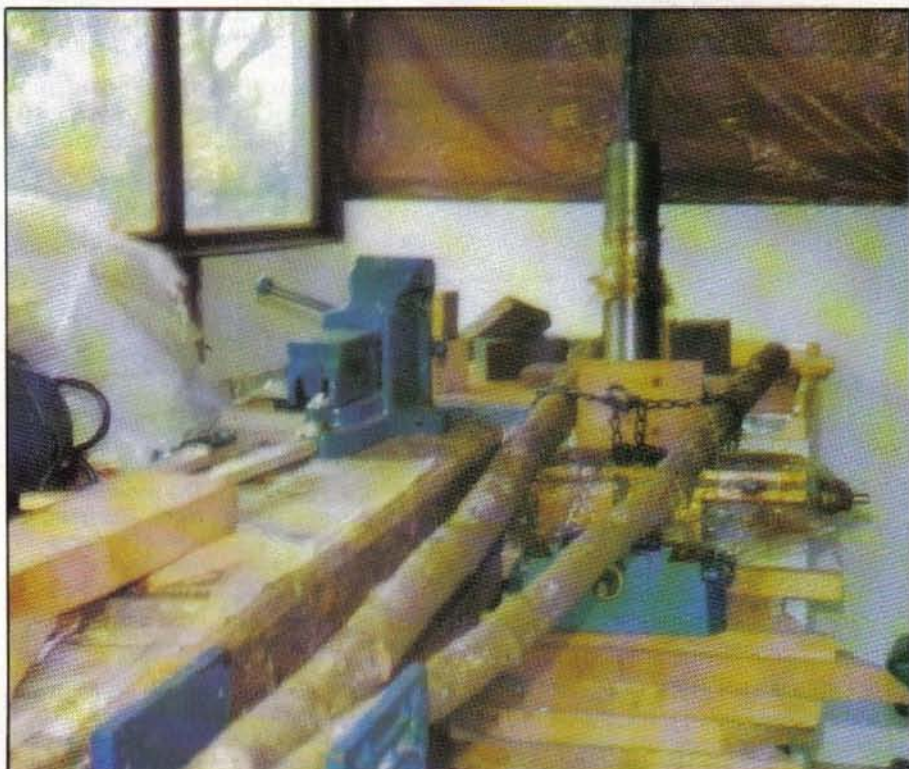
At the 1988 Model Engineer Exhibition I purchased a Naerok RDM 350 milling/drilling machine (usual disclaimer). It was reasonably low priced and quite accurate enough for my immediate requirements, but it was heavy (about 350 lb). This weight is not particularly difficult to move across a floor – in fact, I sometimes move my Boxford AUD lathe (600 lb), but I had never tried to lift some 3 cwt by 2 ft. 6 in. or so, single handed. (My friendly neighbours all have back troubles and the rest think I am crazy anyway.)

My wooden workshop is 10 ft. x 7 ft. so space is limited. Worse, the headroom is less than 6 ft. 6 in., too low for a hoist. The floor is wooden also and is supported on sleeper walls 1½ ft. deep into the ground. Why? Well, that 1987 gale dragged tree roots from under the earlier floor supports, and it pulled the back off the workshop for good measure!

The arrival

The milling machine duly arrived one afternoon and was left on the patio just 20 ft. from the workshop, but there is a 15 in. drop to the garden path and a 12 in. climb into the workshop. There was also a storm brewing. True, I had plastic sheets available and the contractors had brought the machine further than I had expected.

On opening the crate, I found that the machine was bolted to a pallet. The motor was strapped to the vertical pillar and the accessories tied to the cross slide. All electrical connections had been made. Everything was thickly covered with soft



The lift at an intermediate stage, the poles, chain attachment and packing blocks used to rest the base of the machine between lifts. For the purpose of the photograph the poles were rested securely in the jaws of the woodworking vice on the bench.

grease like Vaseline, which soon got everywhere.

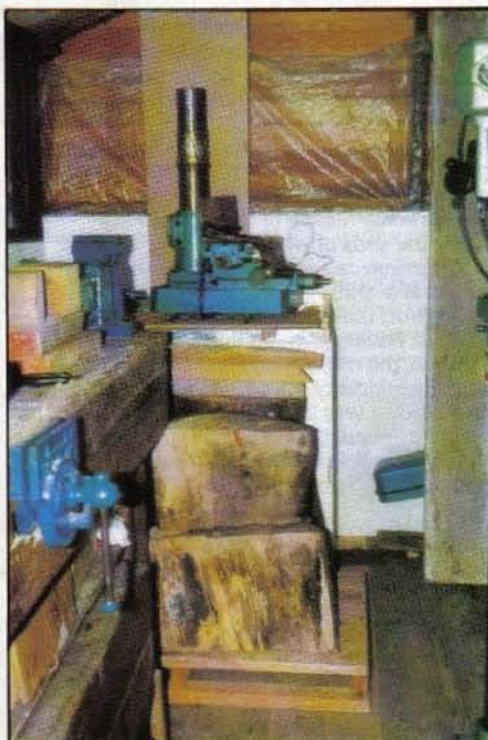
For a start, all loose items were removed, also the milling head. This weighs about 100 lb and is easily unclamped. The remainder (base, pillar and cross slide) weighs about 220 lb.

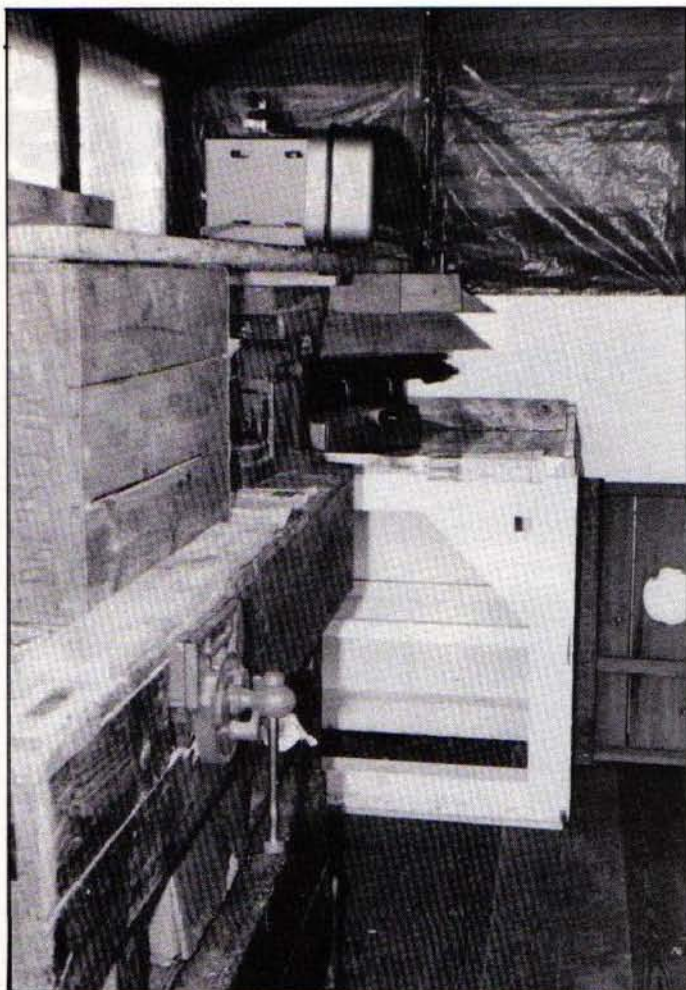
With the aid of a short scaffold plank, rollers (old water pipes) and blocks of wood (left over from that gale) it was not too difficult to get the pallet, etc., down the steps, along the path and up into the workshop. Slow and undignified maybe, but so what! There it was stored whilst a wooden stand was made, because I wanted a base larger than the minimum to spread the load. The extra storage space would also be useful.

The stand came out at 29 in. high (why, is another story) but how do you go about getting a 220 lb chunk of iron onto it gently and in complete safety?

Note the use of squared off blocks of tree trunk used as packing, and the wire to secure all against slipping, whilst not contributing to the lift (far left). Not mentioned in the text is the stout timber "spreader" to keep the poles apart and to prevent the chain from marking the column of the machine during the lift.

Left, the end of the lift of the base. It has now been moved across the plank and only needs to be slid across the bench to be bolted down at its designated position.





The head of the machine, minus the motor was raised in similar fashion, but high enough to allow mounting over the column. Seen here supported on a scaffolding plank, it was next slid across to be re-united with the rest of the machine.

The moment of truth. The head is now tilted and manoeuvred so that it can be slid onto the column of the machine.

The lift

After much thought and some experiment, it was done this way. To begin with, I have some chunks of tree trunk and springy willow poles about 9 ft. long, left over from the gale, also some old fencing chain shackles and assorted blocks of wood. This would be my lifting gear.

The photographs show the method and various stages in the lift. Briefly, it is a lever system using the chain to take the weight. (Rope is easily cut by the base casting and so is unreliable.) The fattest ends of the poles rested on blocks on the stand, the other end was supported by the workbench in my case, although any firm table would have been as suitable.

Next the chain was passed under the mill base (now unbolted from the pallet) and over a pole, about 2 ft. 6 in. from the thick end. To prevent slipping, the chain was strapped to the vertical pillar, with a 16 swg binding wire, but in such a way that the wire did no lifting.

The lift proceeded cautiously. Each item was tested separately. Each pole was used to lift the base on its own, bumping the end of the pole on a block to make the test more severe. Thereafter, two poles were always used. The chain was tested singly similarly, thereafter used only doubled. The poles were never allowed to slope more than 50 degrees.

Once satisfied that all was well, the main lift began. One forearm lifted the thin ends of the poles, whilst the other hand positioned the blocks. At the top of each lift, the underside of the mill base was packed securely with suitable blocks, then lowered onto them. The chain was then shortened and the sequence repeated. Chunks of tree trunk were inserted

whenever possible. These had been cut as square as possible for safety reasons. When the chain could be shortened no more, ever thicker blocks were built up on the stand instead, until a short plank could be put underneath the base, bridging from the stand to the bench.

The base was then inched across the plank by sliding the poles across a little and then lifting so that the base was dragged gradually across. It was then bolted into position, using holes that had been pre-drilled (including the one for the pillar to pass through!) A suitable template had been made previously, using the machine itself, to be sure of having the exact dimensions.

The milling head was then refitted. Two men could have lifted it easily (without the motor) but, in my case, it was strapped on its side in the middle of an 8 ft. scaffold plank, the ends of which were progressively raised in turn, using suitable supports (technical name for wooden boxes) until the required height was reached. Having lowered the pillar as far as possible, the milling head was set upright with the middle of the casting supported on a block. It was then not very difficult to swing the head round and raise the pillar through the hole in the head, finally clamping all in position.

Conclusions

This procedure sounds more elaborate than it is to do. In fact, each stage is stable and so the job can be left safely at any stage. However, for safety reasons inquisitive outsiders need to be excluded.

Incidentally, if large blocks of unseasoned wood are needed for this purpose, your local tree surgeon may have

exactly what you need. Many burn their logs anyway and you could always offer to return yours later!

Many potential owners of heavy bench milling machines may have been deterred from purchasing one because of the difficulty of finding people capable of coping with the weight in a confined space. This is one way of overcoming the problem and may tip the balance.

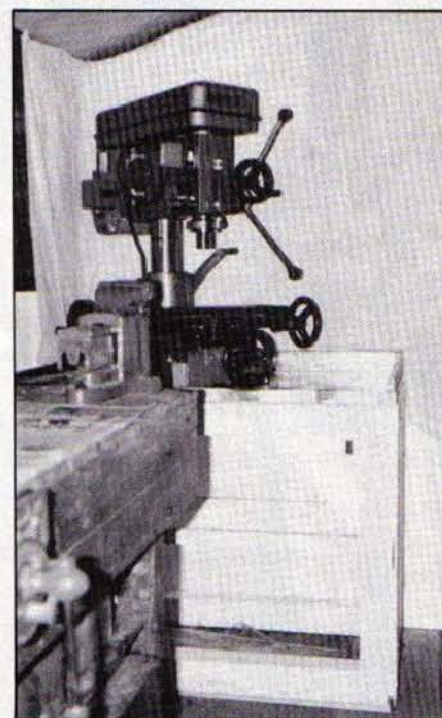
Warning. Heavy weights must be treated with respect and kept under control at all times.

The method is safe in methodical hands, but you must know your own limitations – self-confidence, but not bravado. Haste and short cuts may herald disaster . . .

Finally, always stay well clear of any danger zone – just in case!



Success! The machine now wholly reassembled (below) and ready for use, a tribute to the perseverance and ingenuity of the owner.



SIMPLE DIVISION ON THE SMALL LATHE

It has long been standard practice to use lathe change wheels for simple dividing purposes. On the now popular small lathes such as the Unimat, Toyo, Peatol, etc., there are, as a rule, no change wheels available. Another problem is the fact that the quadrant used for mounting the change wheels is also used for the detent which fits into the gears to give the divisions.

There is no reason why this should prevent dividing. The drawings show a detent fixture made for the Toyo 210 lathe. With a little adaptation the device can be fitted to any lathe. It works on the principle of using a single screw hole and resting the base on the bench. In order that this can be fitted correctly the screw hole has a slight slot to allow adjustment.

The bracket

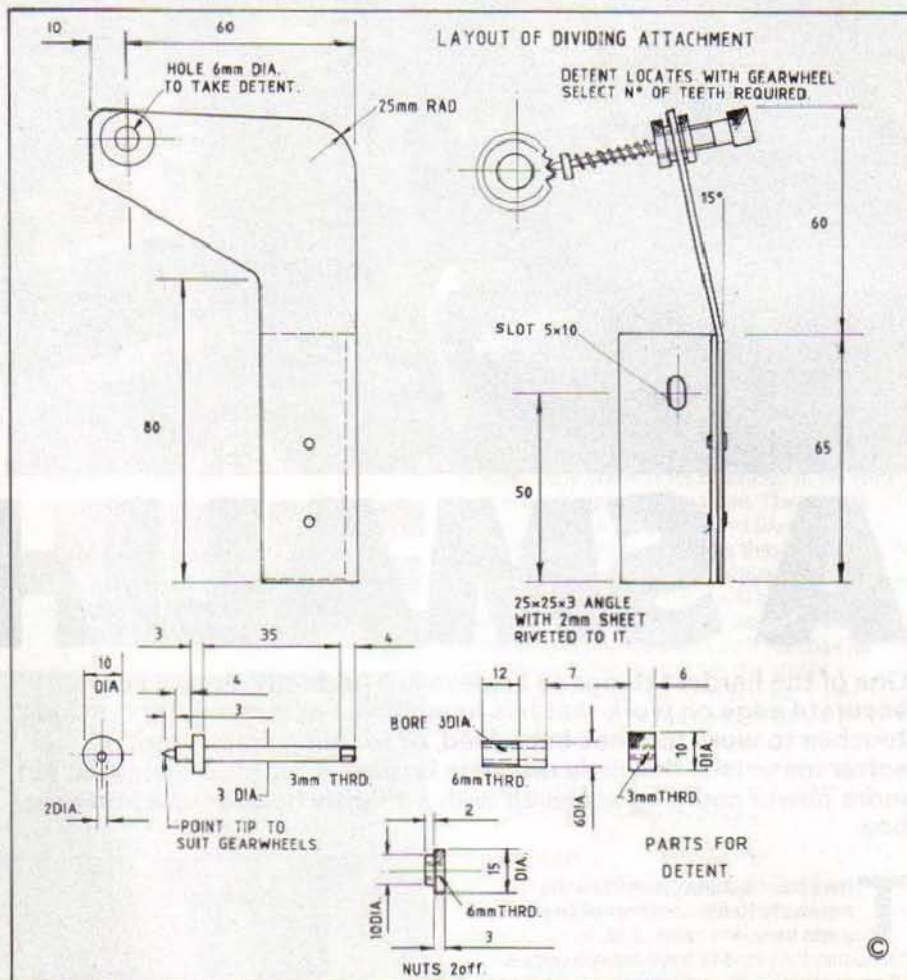
The bracket is in two parts. A piece of $25 \times 25 \times 3$ mm angle iron is drilled and slotted for the fixing screw, and riveted to it is a piece of 2mm thick sheet metal shaped as shown. The detent fits through that.

Gear fixing

The gear used was from a pack bought at Messrs Proops Distributors Ltd. Heybridge Estate, Castle Road, London NW1 8TD. The pack contains a whole range of gears suitable for dividing, and they can be interchanged to get the required number of divisions. The fact that the gears are of plastic is of no consequence. A fitting was made to go on the outside of the mandrel and secured with a grub screw on the flat that is machined on the mandrel. The gear was tapped 5mm to make it easier to fit to the adapter. It is locked with a nut as shown.

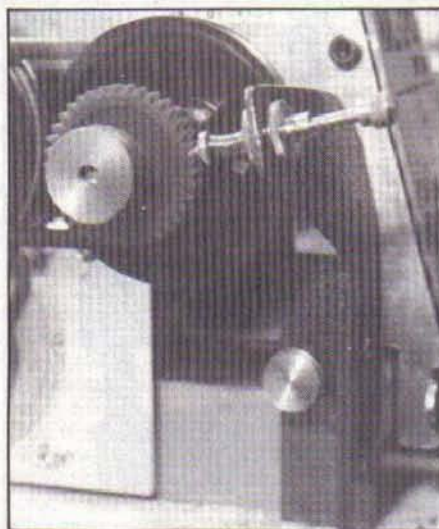
There is no reason why other suitable gears should not be used, but no doubt this would involve a slightly different fixing as the hole diameters will vary. The device is ideal for use with the milling attachment and has proved to be quite accurate.

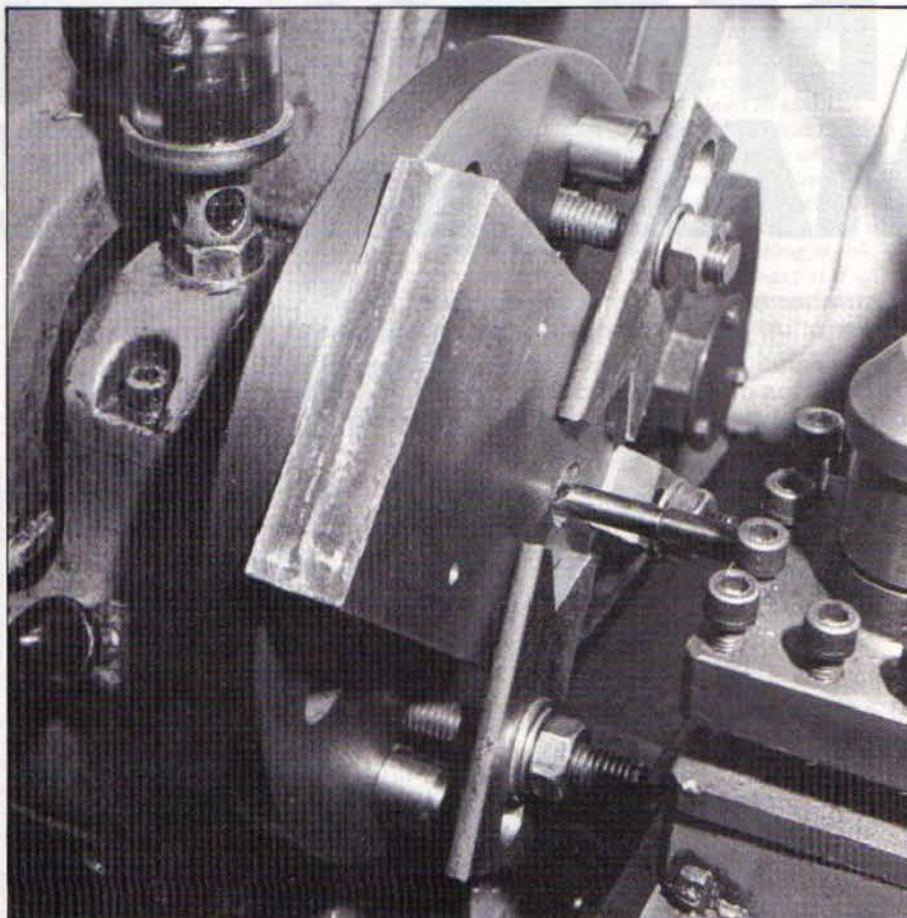
A number of readers have asked for a simple dividing method for the smaller lathe. The method described by Ted McDuffie in this issue is absolutely superb and could be adapted, but there are no backplates on the chucks for most small lathes and this would cause problems. The idea uses very cheap plastic gears



Left: The Fitting on the Toyo 210 lathe for dividing. A simple plastic gear is quite satisfactory. It is held to the mandrel with a simple screw attachment which fits over the mandrel and locks with a grub screw. For extra security the gear wheel has also been tapped.

Below: Two views of the body of the attachment, showing the very basic nature of its make-up. The spring should be selected to be reasonably firm, so it will not allow the detent to slip out of the mandrel during dividing operations.





The shaft hole was bored with the body mounted on the faceplate.

The motor

The first thing was obviously to search for a suitable motor. Not a lot of power is required and the idea was to use one from a sewing machine. A gearbox would be needed, and it was thought to try a worm and wheel. Whilst a search was being made, a shaded pole motor with gearbox was spotted in the catalogue of Whistons of New Mills, Stockport. Under the number 3153A it was described as being a 240 volt motor with a five minute rating, and being continuously rated at 110 volts. Five minutes did not seem to be a practical time for the use of the machine, but the gearbox sounded useful with a reduction of thirty to one. When the motor arrived it was found that it was impractical to use the gearbox separately.

The motor was temporarily put aside and then used to run in a recently completed model steam engine. Although the engine was very stiff it coped with it well, being dutifully turned off after every five minutes. At one point it was started and other matters intervened and after about ten minutes the motor showed no ill effects, other than being on the warm side, which one would expect to find anyway with a small electric motor. The legend on the motor stated the voltage but not the time rating and so perhaps the dealer was unduly cautious.

Thought was given to using the

A SMALL FILING

One of the hardest things to achieve is a perfectly square and accurate edge on work that has been filed. For putting the finishing touches to work that has been filed, or for filing small work in softer materials, this little machine is ideal. A motor is specified but more power could be achieved with a slightly heavier unit and gear box

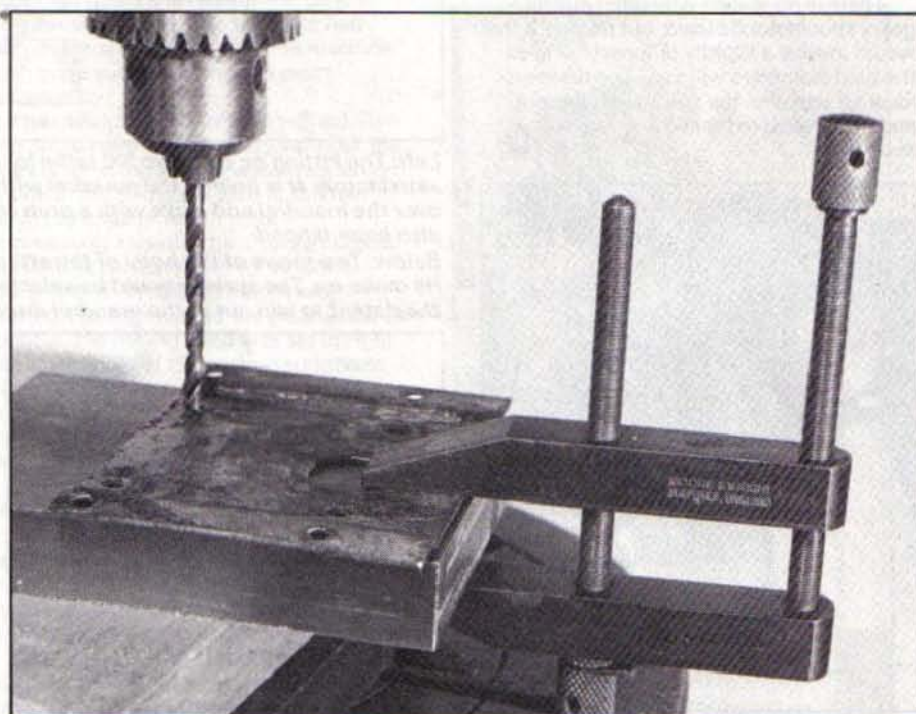
complete unit, which was very compact and had four mounting screw holes ideally placed. Some experimenting showed that the required filing operations were rarely carried out for more than about ten minutes at a time, and as the machine would file more efficiently than doing so by

This little machine grew from the necessity to file some small brass parts very accurately and, in particular, they had to have square edges. Filing machines are not intended for heavy work, and this one is certainly no exception. However, it is possible to file very accurately with them. The files used in this case are standard needle files, but a word of warning to would-be constructors. Decide on the make of file that is to be used and stick to it. Some foreign needle files have odd sized shanks and it really is much better if the shank is a reasonable fit in the holder.

Filing speeds

Ideally, a speed of between ninety and a hundred and twenty strokes a minute seems to be about right for good, accurate filing, although no doubt up to fifty percent could be added to this without doing too much harm. As it happened, the original machine worked out at ninety strokes a minute because of the available materials.

Drilling the body through the plate from the motor.



The finished machine with guard and cover. There should be as much air circulation as possible through the guard, and the hole through which the motor wires will protrude should be fitted with a rubber grommet. THE WIRES MUST BE INSULATED WHERE THEY ARE CONNECTED TO THE MOTOR.



Left: The motor obtained from Whistons with the extension sleeve fitted to the shaft. Other small motors can be used with a 30:1 gear box.

Below: The connecting rod and crank. Note the slot in the crank which allows an adjustable stroke to the file.



Crank movement

If half inch plate has been used for the frame, then no doubt the crank could be fitted directly over the spindle of the motor and secured with a grub screw. With the thicker plate it was necessary to fit a collar first and then fit the crank over this. The throw of the crank does not need to be very great, but must be adjustable. The reason for this is quite simple: round files vary in diameter and get smaller as they reach the end. This means that, if a radius is being filed, the radius of the file will change with the length of stroke, so it is essential that, where a shaped file alters as it reaches its tip, it is possible to shorten the stroke so that only the area required is used. Even the full stroke does not need to be very long. Whilst with larger files the whole length is usually used, with needle files it is not unusual to use a very short movement, and the machine reproduces this.

The base

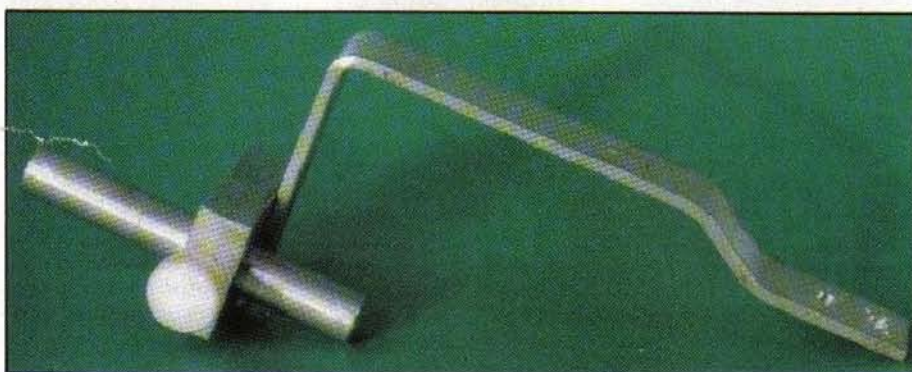
The piece of metal which forms the base was simply screwed to the upright section of the body. It was marked out and drilled tapping size, and the drill then passed through to the upright. The upright section was tapped and the bottom holes opened out to clearance size and countersunk.

The slides

The slides are made of mild steel and those on the machine shown were milled out to form the groove in which the block slides. There is no reason why two thinner pieces could not be screwed together. There would be advantages in making them this way as the end result would probably be a much smoother slide. They are fitted to the body with three screws, but one set of clearance holes on one of the slides should be made into small slots to allow some adjustment sideways of the slide in order to get a good running fit.

The sliding block

The sliding block is of brass. Again it was milled from a solid piece. Most readers are unlikely to have a piece of metal of this



A view of the simple guard arrangement.

hand there appeared to be no reason why the unit should not be used as it stood.

The frame

A start was therefore made on a frame. A piece of $\frac{3}{4}$ in. thick plate was used; $\frac{1}{2}$ in. would have been more than adequate and, as it turned out, would have suited the unit better. The spindle just about protrudes $\frac{3}{4}$ in. and so the frame plate covered it completely – with half inch plate there would be more room to get at the spindle. Nevertheless, the $\frac{3}{4}$ in. plate was used, but readers could well consider the use of the thinner material.

On the motor was a plate secured by four screws. This was taken off and used as a jig into drill the holes for mounting the motor. It was simply held to the frame plate with a toolmaker's clamp and, after

ensuring it was square, the holes were spotted through with a $\frac{3}{16}$ in. drill. The spigot hole is off centre both vertically and horizontally. It seemed to make sense therefore to use the plate to mark out the spigot hole. Dividers were set to half the hole diameter and, with one leg pressed against the side, an arc was scribed. This operation was repeated in three different points. The result was a mark at the central point of the spigot hole, which was then centre-punched.

The four holes were drilled clearance 4mm, as that is the size of the threads used for mounting. The centre hole was drilled half an inch diameter. This proved not to allow the plate to fit flush to the motor and so the plate was put on the lathe faceplate, and bored to $\frac{3}{4}$ in. which gave more than sufficient room.

size and in that case there is no reason why it should not be fabricated. The slide section can be soft soldered to the part that will hold the file. The sizes can be adjusted to suit available material, the part holding the file can easily be reduced to half an inch square, and this would leave the slide as $\frac{1}{2}$ by $\frac{1}{2}$ in.

The block is drilled to take grub screws to secure the file, and also needs a tapped hole to accept the pin which is made from bronze. The hole for the file should be drilled with the block held in the four-jaw chuck in the lathe in order to ensure that it is accurately lined up.

The crank

The crank is made from a piece of mild steel strip, the slot being either milled or filed. The hole that fits the motor spindle must be true at ninety degrees to the length and so, once again, should be drilled in the four-jaw chuck. The crank is held on the spindle with a grub screw.

Connecting rod

The connecting rod is again made from mild steel strip and is fitted at the end which passes over the crank pin with a bronze bush. The other end will be running on a bronze pin and so an ordinary hole will do.

The table

The table is made from a piece of $\frac{1}{4}$ in. steel strip or plate; it should be checked to ensure that it is flat. It is fitted to the body with two pieces of 1 in. $\times \frac{1}{4}$ in. mild steel angle, one piece being held to the body with four screws and the other to the table with two. The quadrant slot can be milled



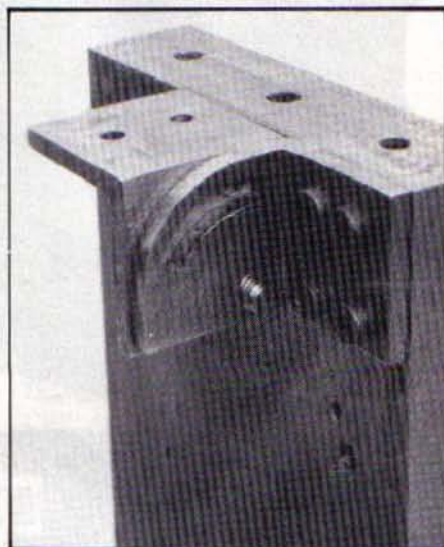
The body mounted on the base.

if a rotary table is available – if not, it can be filed. The actual filing machine was pressed into service for the purpose, the three holes in the base being transferred to the top of the body and the base screwed in the table position while the filing operation was carried out. The slot was first chain drilled and roughed out with a file. (The machine is not designed for the heavier roughing out part of the job.)

The hole for the file to pass through is elongated a little to allow the table to tilt, and a knurled screw holds it in the required position. It is essential that the table lies at ninety degrees to the file when in the normal position.

Wiring the motor

There is nothing to wiring the motor; there are simply two terminals to which wires can be attached. Push-on terminal connectors were used, and these were insulated completely for the sake of safety. There is no reason why the wires should not be soldered in position; if so, the shrink type insulation to cover both terminal and wire is advised. An earth wire should be connected somewhere convenient on the motor for the sake of safety.



The quadrant and table bracket in position.

The case

The case covering the motor was a simple bending job from a piece of scrap steel. Four holes are made to allow heat to disperse, and a further hole takes a rubber grommet for the wire to pass through. The case should be secured with a couple of screws to prevent it falling off during operations.

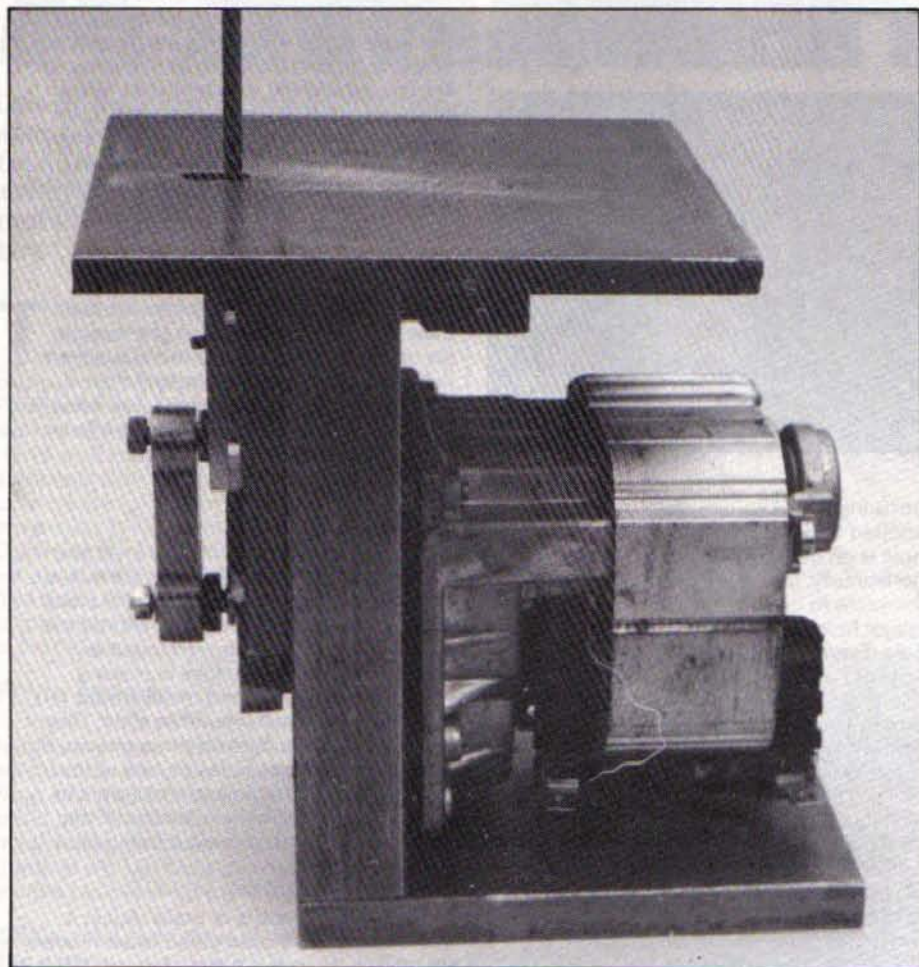
Improvements

As far as the compact little machine shown is concerned, that is all there is to it. It has to be conceded, however, that there is a lack of both power and running time. The introduction of a simple gearbox will allow a heavier duty motor to be used, but will mean that the machine is no longer so neat and compact. We cannot have things both ways, however, and so a decision will have to be made whether the extra power is needed...

A gearbox

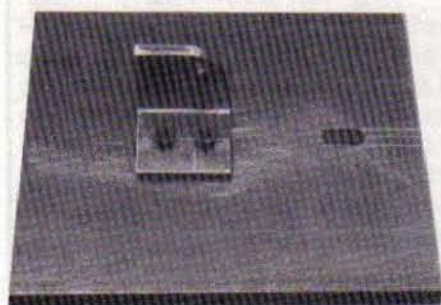
A gearbox can be made using a simple twenty-five or thirty to one ratio worm gear. Such a gear can be purchased from a model railway dealer who deals in Gauge 'O' models. Alternatively, suitable plastic gears are available from Messrs Proops Distributors Ltd, Heybridge Estate, Castle

The machine assembled ready for use, but without cover or guard, both essential in the cause of safety.

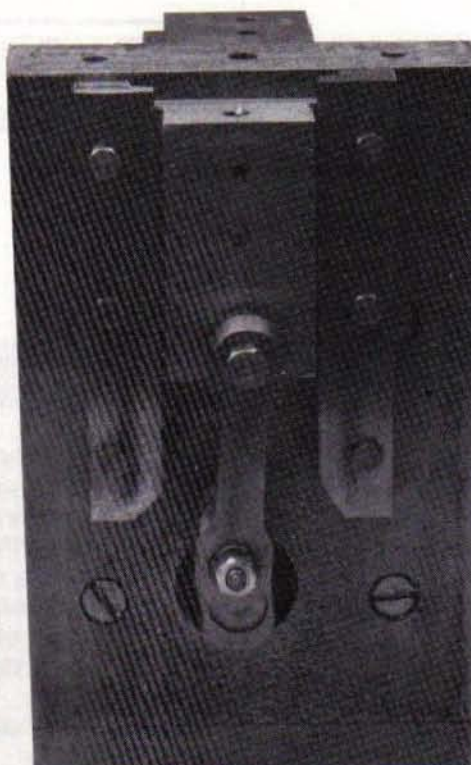


Road, London NW1 8TD. Telephone 071-267 6911. These are particularly robust. The wheel is connected to the crank via a shaft which runs in bearings, and whilst ball races would be ideal and small ones are sold that would do the job, ordinary bronze would be quite suitable. No dimensions can be given because the gears are likely to vary according to the type purchased.

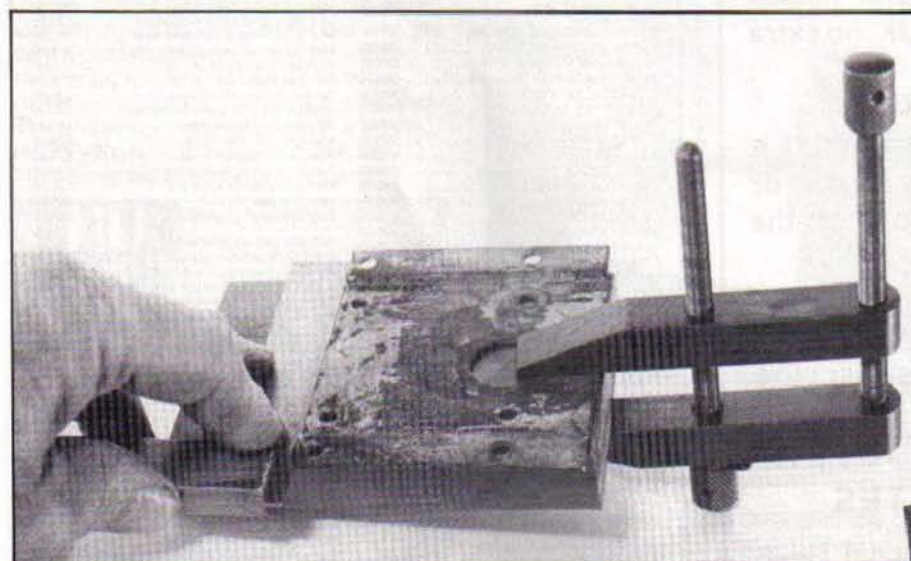
The worm should also run on a shaft in bronze bearings and an adjustment in the form of slots must be left to get it running right. It needs to mesh with the wheel in such a way that it is neither sloppy nor binding. One way of checking the mesh is to put a piece of notepaper between the



The table bracket mounted on the underside of the table.



The front of the assembled machine.



The motor plate is to be used as a template, and here we see it clamped to the body and checked for squareness.

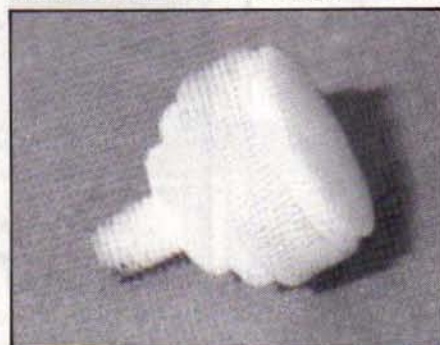
gears as they are closed up – this should give about the right clearance.

Fitting an alternative motor

There are a number of small motors available on the second-hand market that will run the machine – anything from about a sixth of a horsepower upwards would give more than enough power. How the motor is connected will have to be a matter for the individual. It can either be with a belt via pulleys or, perhaps if a small enough one can be found, the shaft can be connected direct to the worm. Obviously, the motor mounting holes shown in the drawing will not be required, and a different base will be needed to hold the motor. Such things must be left to the individual constructor as covering all eventualities in this article is simply not practical.

Once again, Messrs Proops Distributors hold suitable motors, but stocks vary considerably and so contact will have to be made direct with them. At the time this was

written Peatol Machine Tools W.E., 19 Knightlow Road, Harborne, Birmingham B17 89S had a considerable number of suitable motors in stock at very reasonable prices, and one of these was used in conjunction with a Proops set of gears to drive the machine at a later stage.



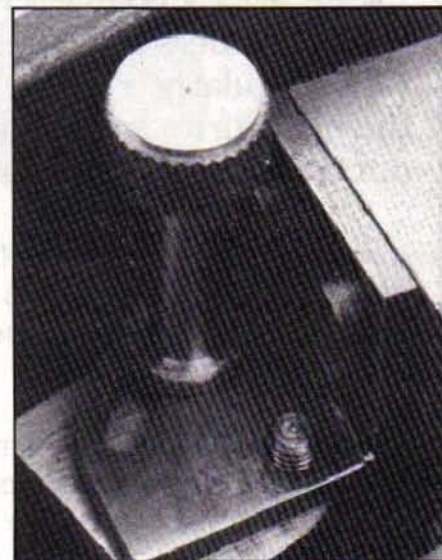
The screw for adjusting the guard must be made from a soft material, like this nylon one, to prevent crushing the tube.

Uses of the machine

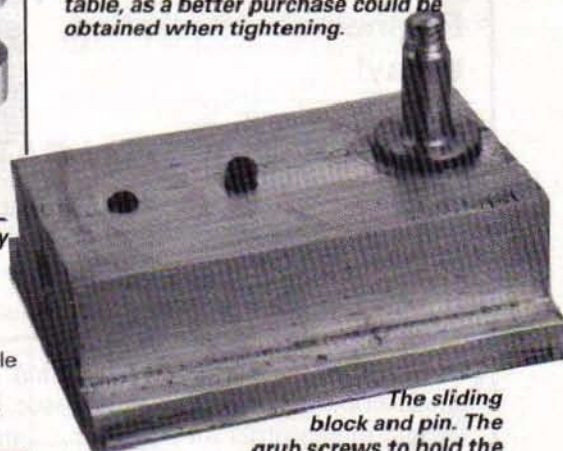
Accepting the limitations of the machine, it is ideal for those fiddly little bits of filing, particularly useful, being the ability to get edges square. It is ideal when making model boat fittings, or parts for small gauge model railway locomotives. It is also useful for filing square holes for fitting tools, etc. and can really come into its own when making gears for clocks.

Safety

Even with a small, low-powered machine such as this we must think of the safety angle. The electrical side has already been covered but it is important that no loose wires are left, and that the machine is properly earthed at all times. The other big



The adjusting screw. It was later found that it was better to use a screw that protruded a little further beyond the table, as a better purchase could be obtained when tightening.



The sliding block and pin. The grub screws to hold the file can be clearly seen.

danger is from the moving files. Needle files have sharp points and the fitting of a guard is therefore advised. If the size of the work makes this impossible then there are two options. The best by far is to grind the files to a suitable length so that they are short enough to prevent any real danger to the user. If this is considered a bit drastic, then ensure that every time the machine is used a big blob of Blu-Tak or similar material is put over the file end. This should prevent nasty accidents. The biggest safety factor of all must, as is always the case, come from the operator him or herself, who must at all times take care when using the machine.

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AEW Viceroy Vertical Mill 3ph	£1,750.00	Abwood 6" Swivel Machine Vice	£100.00
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Quatters & Smith 6" 3ph	£300.00	D'Andrea 50 INT Boring Head	£200.00
Wellsaw 4" 1ph	£200.00	S.J.P. Boring Head (Jib Borer)	£225.00
GRINDERS		Saltap Tapping Head, 10 Collets	
Vanco Linishers	£150.00	1" Shank	£75.00
Clarkson Tool & Cutter Grinder 3ph	£600.00	Saltap Tapping Head, 10 Collets 2 MT	£75.00
SHAPERS		SPV Tapping Head, 9 Collets 3 MT	£100.00
Adapt No 2 Bench Shaper 1ph	£150.00	Dickson S2 G.C. Toolholders	£25.00
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Change Gears: 16T-C10, 20T-C11, 21T-C11, 23T-C11, 24T-C11, 27T-C11, 28T-C11, 30T-C12, 31T-C12, 32T-C12, 35T-C12, 36T-C12, 37T-C12, 40T-C14, 41T-C14, 43T-C14, 44T-C14, 46T-C14, 48T-C14, 52T-C15, 53T-C15, 54T-C15, 56T-C15, 59T-C15, 60T-C15, 71T-C18, 75T-C18, 79T-C18, 80T-C20, 100T-C25, 127T-C25		Record No. 110 Engineers Vice	£50.00
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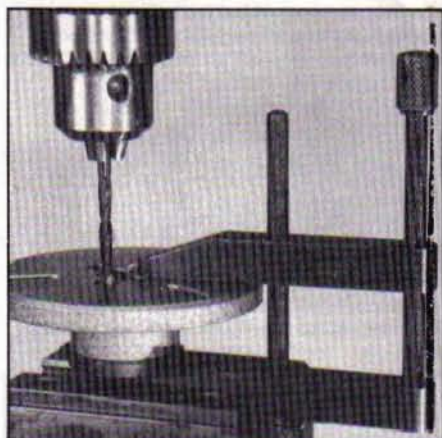
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THIN PIECE CHUCK

Holding very thin work in a lathe chuck is fraught with danger – danger to the operator from the work possibly flying out of the chuck, and danger to the chuck itself by straining the jaws through using only the edges. The answer is a thin piece chuck as described here. Whilst at first glance such a project may seem quite daunting to the novice, it is, in fact, a comparatively simple piece of equipment to make and will repay the time involved in its construction a hundred times over

Gripping thin pieces of metal in the lathe, or on the milling machine, can be very difficult indeed. We have already published a design for a thin piece vice which, whilst intended for use with the bench vice, could be adapted for use on the milling machine. When it comes to round work a different approach is needed. The simple chuck described in this article works very well and work which is only 1mm or so thick can be gripped and

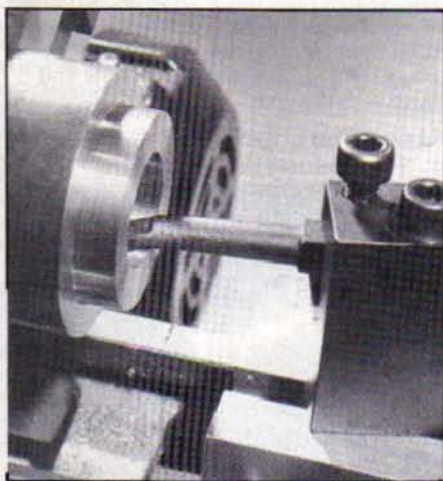


Use the faceplate as a guide to make the holes in the chuck jig.

worked on with perfect safety. Whilst it is designed for use on the lathe, it can be used in conjunction with a faceplate setting device to work perfectly well on the milling machine. The description relates to a chuck made for a small lathe, specifically a Toyo ML 210, but equally the description will apply to the Unimat, Peatol, Cowell, etc. For larger lathes, different chuck fixings will be required.

Making a fitting jig

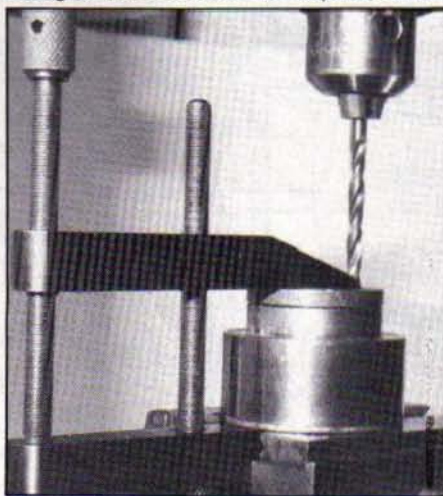
The outer shell is the first part to be made. As already stated, the drawings relate to a chuck for the Toyo lathe. Start by making a jig to fit the mandrel, simply a piece of steel rod turned to a step. The smaller diameter needs to be a good fit in the mandrel of the lathe, but without any slop. However, it should not be so tight that it has to be forced in and out. The large



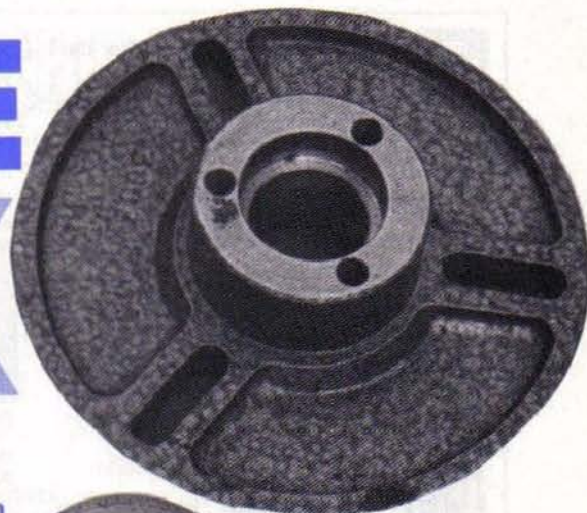
After facing and boring the larger diameter of the chuck, turn it round and machine the lip, and bore at that end to an exact fit for the jig.

diameter is turned to the outer diameter of the mandrel, but exact sizing is of less importance in this case and, if anything, it might be a help to leave it a little on the large side.

The chucks are a three or four hole fitting on the lathe and the faceplate, which



Use the jig to make the fixing holes for the chuck body.

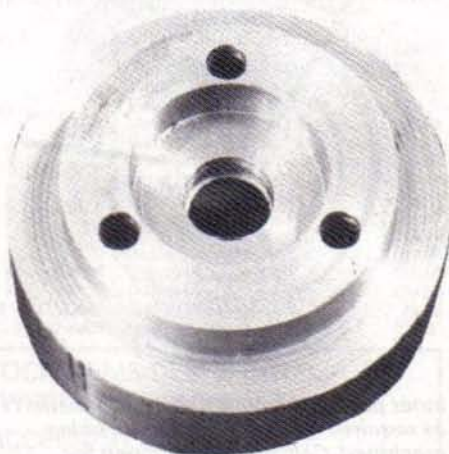


Start by machining a lip on a piece of round bar to fit exactly in the recess on the back of the faceplate.

is three hole, was used as a guide for the holes on the thin piece chuck. The faceplate was clamped to the jig and the first hole transferred right through. A bolt was passed through the jig and faceplate as a security against it twisting out of line, and the other two holes were transferred. After this device has been completed the jig is worth saving as it could well provide the basis for a number of other devices.

The outer shell

The outer shell is from a piece of mild steel bar. Before starting machining, check the diameters of the lathe mandrel and, if necessary, set calipers to the exact sizes. It will not be possible to do this half-way through the work. The bar will have to be mounted with the jaws reversed because of its size. The sequence of operations

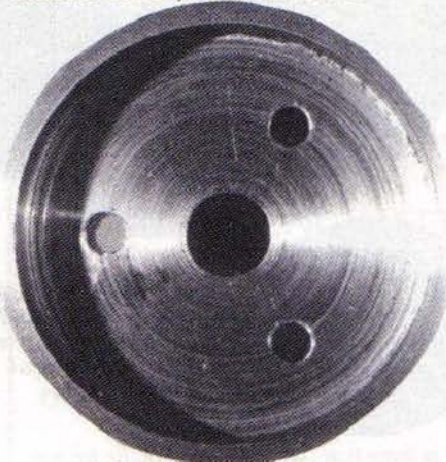


The rear of the chuck body showing the recess and fixing holes.

probably is not all that important but the one shown was faced across and then the small diameter turned to size and bored an exact fit for the mandrel. Here again, the fit must be good without forcing, and there should be no play when the shell is fitted on the mandrel. Of course, it is not possible to take it off the lathe and test it against the mandrel and so careful measurement will be needed. We can use our pre-made jig for measuring, and again it must be a close fit without force, and without play when

completed. The jig can also be used for the outside measurement.

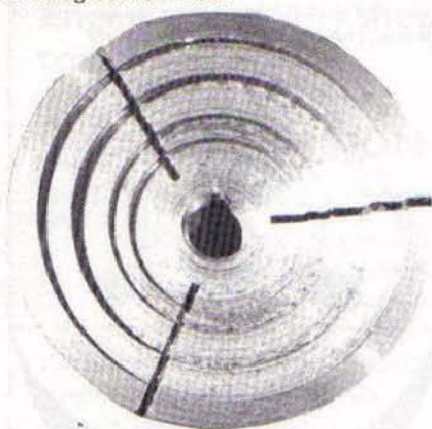
Once the small diameter and the bore is done, the work can be turned round, as can the chuck jaws, and the larger bore can be machined. The end face must be square and the bore should be left just short of the finished size. Once again, it is emphasised that, although sizes are quoted, they can be altered to suit any available material.



Front of the chuck body; it needs mounting on the mandrel and the 1" taper machining.

Fitting the shell

With these operations complete we should now have our outer shell looking something like the finished article. The next thing is to drill the three holes for the chuck fixing. With the jig which we started with this is an easy operation. Clamp the jig inside the small end and transfer the hole right through the shell. Use a bolt for security and make the other two holes. The shell can now be fastened to the lathe in the same way as a chuck and the taper of one degree machined.



Inner part of the collet; steps are made as required to suit components being machined. Centre hole is tapped for draw bar, outer diameter has 1" taper.

Inner section

The plug of metal for the inner section will need to be about six millimetres longer than the finished article; this will allow it to be gripped in the lathe chuck for machining. Turn the one degree taper so that it is about 0.5mm larger in diameter than the internal taper of the outer section. Drill and tap 8mm diameter for the draw bar. Remove it from the chuck, and make up the draw bar and handle. Put the outer section in the chuck securing it with the

screws. Put the inner section in it and tighten the draw bar but do not overtighten.

Making the collet

The required diameter steps can be machined at this stage. The smallest one should be made exactly to fit a washer of known size, so that the washer will push in

appropriate groove – it should be a good fit to start with. The draw bar will pull the inner part of collet in to the taper and close it down giving a tight grip. It is possible to machine any new diameters that might be needed. Simply slip the washer in the inner recess and tighten up. The collet jaws will then be supported sufficiently open to



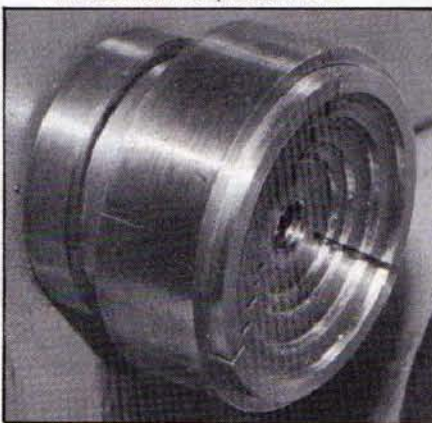
Draw bar and securing handle.

with a little difficulty, but not great force. Any other stepped diameters are machined an exact fit for whatever components are to be machined in them. It does not matter at this point how many steps are machined, but the small one is essential.

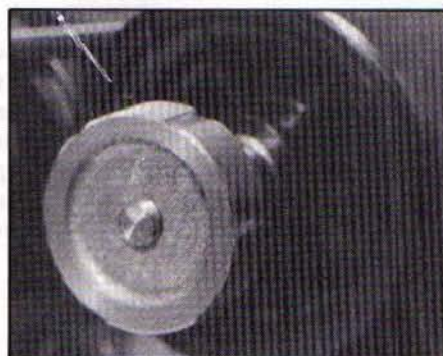
Take the inner part out of the chuck and mark it off in three equal parts. This can be done by putting it in a three-jaw chuck and scribing along the jaw edges. Carefully saw down from these lines until the blade is about 5mm from the draw bar hole. Deburr along the saw marks to prevent a loss of accuracy. You now have a small piece chuck! Finally, face across to get the end flush with the body.

Using the chuck

Thin work can be placed in the



The chuck in position on the lathe.

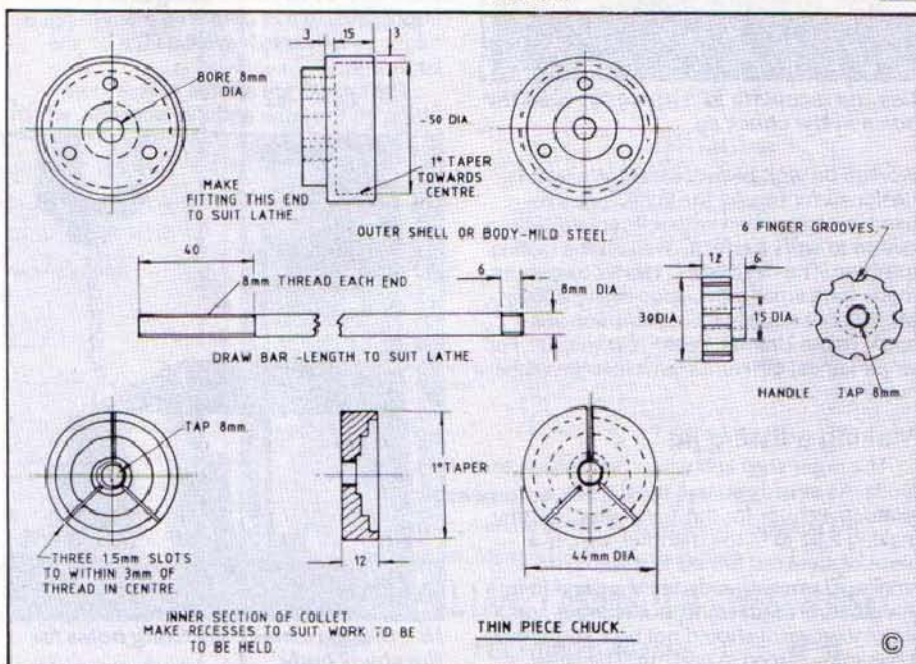


The draw bar tightens the collet.

allow further machining as required. Existing recesses can be removed when finished with and new ones machined in. New collets can be made as required.

Chuck for larger machines

The principle when making a chuck for larger machines is basically the same. Obviously, larger material will be needed but there is no need for this to be excessive and usually around two inch or fifty millimetre diameter material will do quite well. With screw-on chucks the outer section will have to be adjusted accordingly. If there is to be any attempt at quantity machining then a draw bar should be made. If one-offs are all that the chuck is to be used for, a bolt can be used as a substitute for the draw bar. The chuck is simply screwed off, the work put in and tightened and the chuck screwed back on.



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The Geometric Chuck I made is based on the general description by 'Tubal Cain' in the *Model Engineer* (1st September 1978 etc., photocopies are available via Readers' Services - Ed). It was made for use in conjunction with my Myford Lathe. I could not accommodate a 9 in. diameter backplate and settled for 6 in. The rest of the components also had to be reduced in size to some extent. It was intended to be self-contained and used in the upright position only. No castings were used, everything being fabricated, and where necessary screwed together and brazed to ensure maximum rigidity. Most of the materials used were obtained from Whistons, New Mills, Stockport SK12 4PT, including the motor for the flexible drive. The motor being by A.E.I., $\frac{1}{10}$ h.p., continuous rated. Length 4½ in. width 4 in. The rest of the items were already to hand. The wheel teeth were cut with a fly cutter, the details are: Module 0.635; Thickness of cutter 0.03925 in.; Radius at top of teeth 0.03925 in.; Depth of tooth 0.0725 in. A No. 40 drill is a useful gauge when making the cutter. Cutting the teeth in hard aluminium will need a very low speed and lubricant will also be required.

The Chuck is not only capable of drawing patterns, it can also be used to cut designs in wood or other materials. It is important, in the first place, to use the pen to draw the design on paper, keeping a record of the position of the slides etc., in order to reproduce the pattern with the cutter when needed and to make further copies if required. In addition to the lathe, a bandsaw is a must, the other tools needed will no doubt be available.

The action of the Chuck is fascinating to watch. There seems to be no limit to the number of designs it will produce. The fact that the top faceplate can be transferred to

GEOMETRIC CHUCK

A geometric chuck is an old-established device which was much used by ornamental turners – an art which is possibly not practised as much now as it was some years ago. Although described as 'chucks', many designs are not really in that category, even though their function is partly work-holding. A clever arrangement of gears enables the work to be moved in a series of gyrations, which can be varied by adjustments. This excellent example by Mr Allard of Walsall has a whole range of movements. The article is suitable for the more experienced home machinist but, as always, much of the information contained in it can be used for other purposes. The finished result is a fascinating artefact – here's part 1, part 2 next issue

the lathe mandrel in order to shape wood or other materials is a great advantage. Making wheels N, O, & P from phosphor bronze is the only real improvement I can think of at the moment.

A Couple of Handy Hints

What I should mention is that the scope of the machine can be increased by using different wheel-trains with suitable lengths of lazy tongs.

Also I should outline the method used to cut the thread to match the lathe nose. The belt-tensioning lever at the back of the

lathe was pulled up gently just enough to turn the work. This meant when the tool came to the end of the thread inside the Boss and met with resistance, the belt slipped and the turning stopped with no damage to the tool or the work. This method may be "old hat" to many old hands but may not be apparent to some less experienced workers.

Now, having given a very brief introduction to the project, let us set about making it. I have detailed as much of the construction as I can, in the hope that others will find the constructional notes of value.

Centre Arbor and Mandrel, Figures 1 and 2

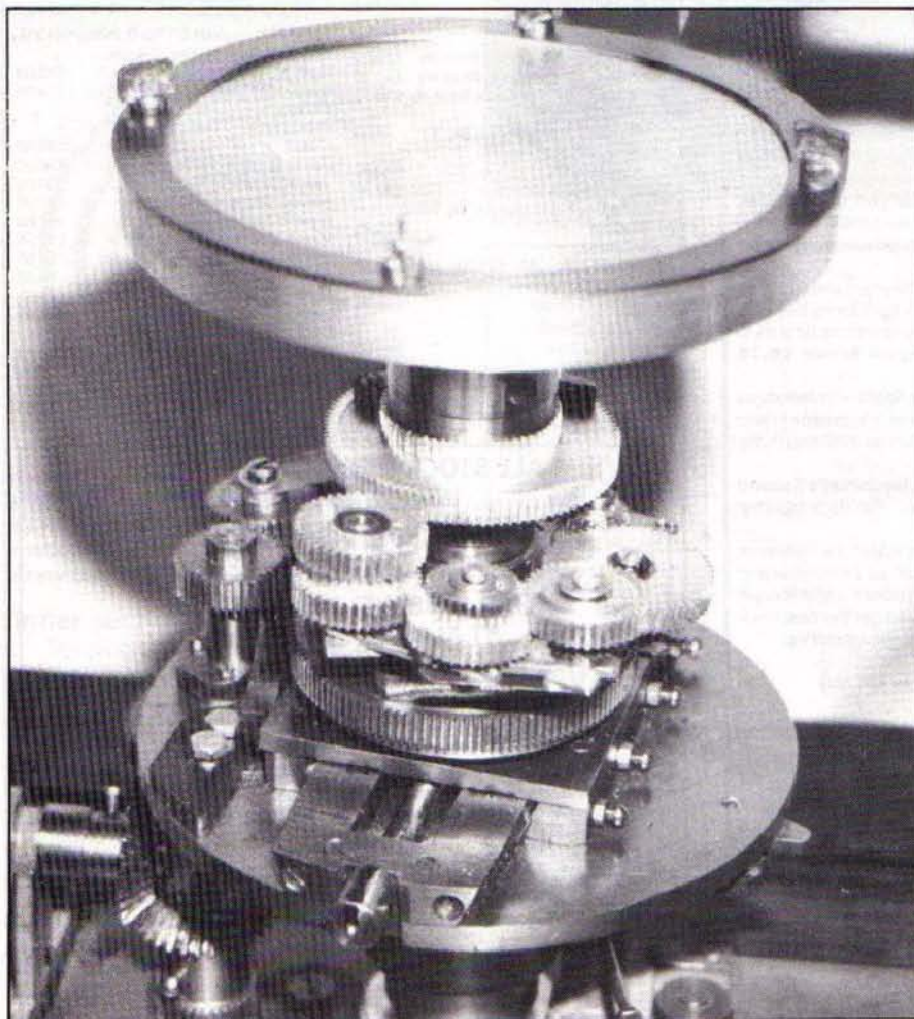
The first items to be made are the centre Arbor on which the whole mechanism revolves, and the mandrel similar to the nose of the Myford Lathe.

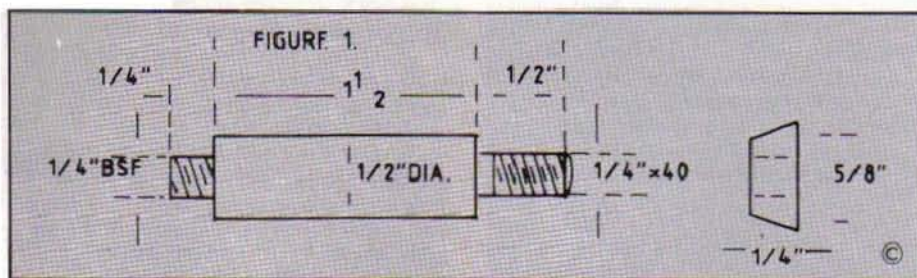
Put a length of ½ in. diameter silver steel 2½ in. long in the three-jaw chuck. Turn ½ in. length at one end to ¼ in. diameter and thread ¼ in. by 40 M.E. Turn round and reduce ¼ in. length to ¼ in. diameter thread ¼ in. B.S.F. Make the tapered ferrule from ⅝ in. dia. brass, tapping the centre ¼ in. by 40 M.E., and setting the top slide over to 15 deg. to form the taper on the outside. Slot the top for a screwdriver.

Put in the chuck 2½ in. length of 1½ in. diameter bright mild steel. Drill with centre drill in tailstock, follow with larger drills and finish by boring out to ½ in. diameter trying the Arbor already made to ensure a running fit with no play. Set the top slide over to 15 deg. and bore a taper until the opening at the top is ⅝ in. wide. Adjust the width of the hole at the bottom of the taper slightly to allow clearance for the ferrule.

Support with the tailstock and from that end turn to 1½ in. diameter for a length of ½ in. Thread 12 TPI or to match the mandrel nose of the lathe in use. Reduce another ½ in. to 1¼ in. leaving a square shoulder. Reverse in the lathe and turn down to a diameter of ⅝ in. for a length of ¼ in. again

A close up view of the geometric chuck showing the vertical mounting.





leaving a square shoulder. Reduce a further $\frac{1}{8}$ in. to $1\frac{1}{8}$ in. diameter. This completes the Arbor and Mandrel, which will be fitted to a baseplate later.

Backplate Boss, Figure 3

Chuck a piece of 2 in. diameter bright mild steel $2\frac{1}{2}$ in. long. Centre drill the tailstock end, then drill to a depth of $1\frac{1}{4}$ in. with a $\frac{3}{8}$ in. drill, follow with larger drills and bore to an inside diameter of 1 in. Bore the last $\frac{1}{4}$ in. inside an extra $\frac{1}{8}$ in. wide to allow clearance for the screwcutting tool. Screwcut 12 TPI, or to match mandrel already made. Cut off the thread for $\frac{1}{2}$ in. inside the bore, using previously made mandrel to check size which should be approximately $1\frac{1}{4}$ in. diameter (thread will need the burr taking off with a small hand tool before it will fit onto the lathe nose.)

Screw onto lathe nose and reduce outer diameter to $1\frac{1}{8}$ in. Turn first $\frac{1}{4}$ in. from tailstock end to $\frac{1}{4}$ in. diameter and thread $\frac{1}{4}$ in. B.S.F. Relieve thread slightly to be sure

of a snug fit in the backplate. Turn down another $\frac{1}{8}$ in. to $1\frac{3}{8}$ in. diameter then a further $\frac{1}{8}$ in. to $1\frac{1}{2}$ in. diameter, follow with another $\frac{1}{8}$ in. at $1\frac{1}{2}$ in. diameter. Round off the shoulder to the maximum diameter.

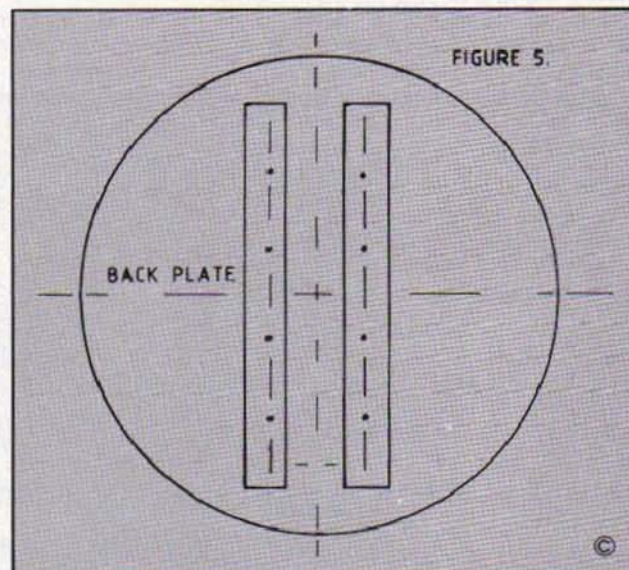
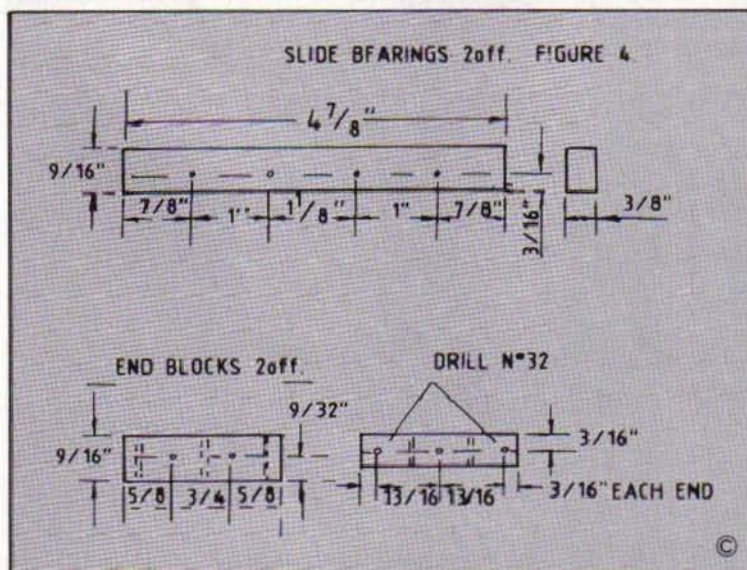
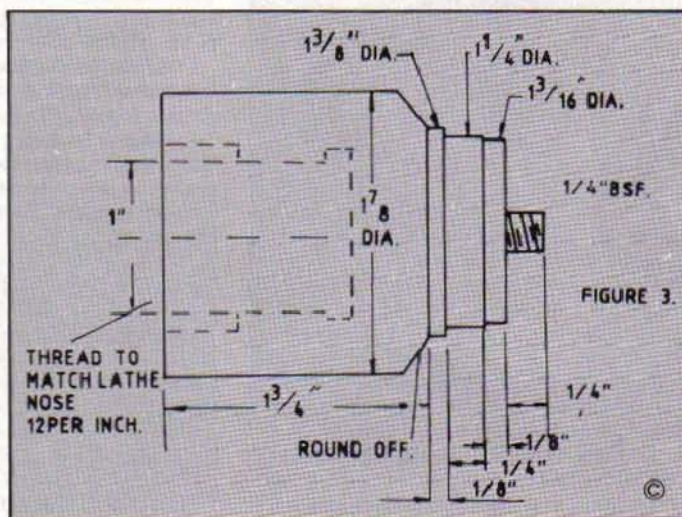
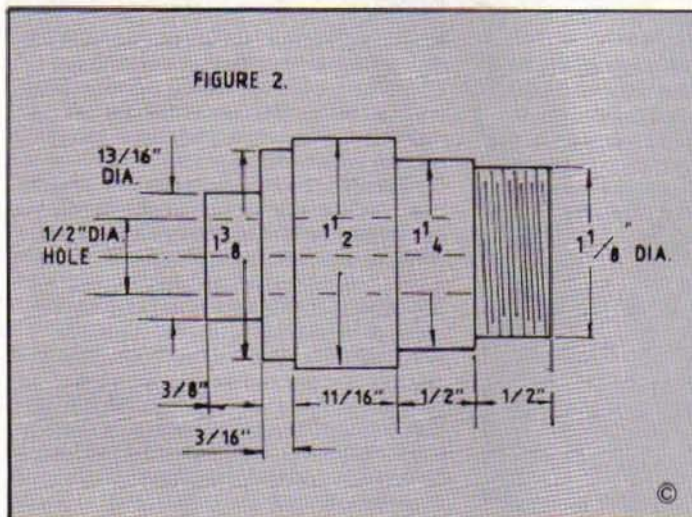
Geometric Chuck Backplate

Cut $\frac{1}{4}$ in. thick bright mild steel to just over 6 in. diameter and punch mark the centre, then mark 4 equal distance holes on a circle $\frac{1}{2}$ in. from the centre. Drill each one No. 32 or 2.9 mm drill size. Drill the centre No. 3 or 5.5 mm and tap $\frac{1}{4}$ in. B.S.F. Screw the plate tightly onto the Boss and drill a short distance through the 4 small holes into the Boss. Remove the backplate and drill the Boss to a depth of approximately $\frac{1}{2}$ in. and tap the four holes 4 BA. Open out the holes in the backplate with a No. 26 or 3.7 mm drill and countersink. Screw the plate to the Boss, insert the 4BA screws, attach to the lathe and turn to 6 in. diameter, at the same setting turning the face true.

First slide bearing, Figures 4 and 5

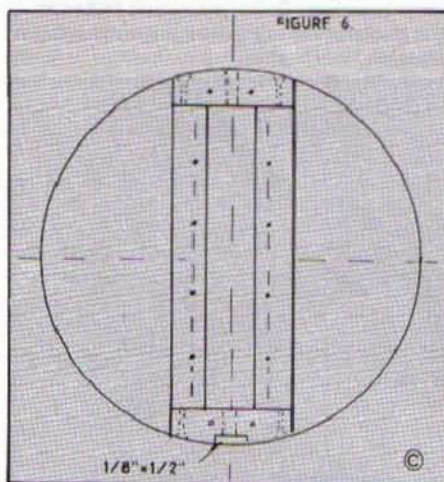
Scribe a line across the face of the backplate $\frac{1}{8}$ in. from the centre, for later use scribe one across the centre and at right angles to the first one. Cut two pieces of $\frac{3}{8}$ in. by $\frac{1}{2}$ in. bright mild steel, $4\frac{1}{2}$ in. long and two pieces of the same material 2 in. long. Drill 4 holes with No. 32 or 2.9 mm, drill $\frac{1}{8}$ in. from one edge on the two pieces $4\frac{1}{2}$ in. long spaced as shown in Fig. 4. Place one of the $4\frac{1}{2}$ in. pieces with the drilled holes inwards on the scribed line on the plate. (The line which is $\frac{1}{8}$ in. from the centre) equidistant from either end, and clamp in position with toolmaker's clamps. Drill through the holes with No. 32 or 2.9 mm drill to mark the plate. Remove the slide bearing and carefully centre punch each mark. Drill No. 32 or 2.9 mm and tap 4BA. Open out the four holes in the bearing with a No. 26 or 3.7 mm drill and countersink. Fasten to backplate.

Cut a $\frac{1}{2}$ in. length of the same thickness and width making sure all edges are square, the ends being smooth and polished. Clamp the other strip to the backplate at a distance of $\frac{1}{8}$ in. from the inside of the first one, again with the screw holes inwards, using the $\frac{1}{2}$ in. piece as a spacer. This must slide between the two strips smoothly from one end to the other with no shake. Mark through the second strip as before. Drill and tap and fasten to the backplate making sure the ends are square.

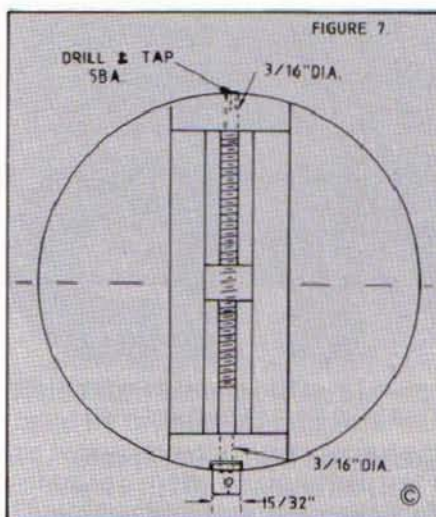


Fitting the end blocks and adjusting screw

Pass a rod of a diameter which is a sliding fit through the No. 43 or 2.25 mm hole in one of the end blocks, positioning the other block at the opposite end, making sure that the rod lies centrally from one end to the other. Clamp one end block and mark through the No. 32 or 2.9 mm holes onto the backplate. Centre punch each mark and drill and tap 4BA. Open out the holes in block and countersink. Fasten to the backplate. Put the $\frac{1}{8}$ in. spacer up to the inside of the block just fastened, mark through the block No. 43 or 2.25 mm hole onto the spacer with a No. 43 or 2.25 mm drill, carefully punch mark and drill the spacer. Pass the rod through the block and spacer pushing it to the other end and fastening the other block as before. Mark through the end holes of the blocks, drill into the slide bearings No. 32 or 2.9mm about $\frac{1}{8}$ in. deep and tap 4BA. Open out the end holes in the blocks with a clearance drill and follow with $\frac{1}{8}$ in. drill to a depth of $\frac{1}{8}$ in. in order to sink the heads of the screws and fasten with 4BA screws. Attach to the lathe and turn down the end blocks to the diameter of the backplate, 6 in. Cut out the $\frac{1}{8}$ in. recess at one end for the turning button as shown in **Figure 6**. Dismantle and open out the holes in each endpiece to $\frac{1}{8}$ in. diameter, open the hole in spacer



(Sliding block) with 5.50 mm drill and tap $\frac{1}{8}$ in. $\times$ 40 M.E. Take $\frac{1}{8}$ in. diameter bright mild steel rod $\frac{1}{2}$ in. long, reduce $\frac{1}{8}$ in. at one end to run freely in the end block with the $\frac{1}{8}$ in. recess, and again reduce the dia to 0.185 in. for a length of approx. $\frac{1}{8}$ in. from the end and thread 2BA. Centre drill the other end and tap 5BA. Turn down so that the rod



runs between the two end blocks without end shake.

Thread the remainder of the rod from the drilled end to within $\frac{1}{8}$ in. of the recessed block with a $\frac{1}{8}$ in. by 40 M.E. Die. (Do this in the Lathe to ensure truth.) See **Figure 7**.

Turning piece

Cross drill $\frac{1}{8}$ in. hex. bright mild steel $\frac{1}{8}$ in. from the end with No. 27 or 3.6 mm drill - this is for the Tommy Bar - part off at $\frac{1}{8}$ in. reverse and centre drill follow with No. 22 or 3.9 mm drill to a depth of $\frac{1}{8}$ in. and tap 2BA. Turn a mandrel to screw the turning piece on in order to remove the flats, and to divide into 25 divisions later.

Dismantle from the backplate. Mark an angle of 60 deg. on the outside of each strip to form a dovetail, and cut with bandsaw or hacksaw. File to correct angle. Smooth and polish the surfaces. Shape the end block which has the recess for the turning button in the same way, See **Figure 8**.

Slide pieces, Figure 8

Cut two pieces of the same material $\frac{1}{8}$ in. by $\frac{1}{8}$ in. bright mild steel to $\frac{3}{4}$ in. long. Drill No. 32 or 2.9 mm for adjusting screws on the $\frac{1}{8}$ in. side as shown and tap 4BA. Mark 60 deg. angle on each piece and shape as before.

Liners for slides - 2 off

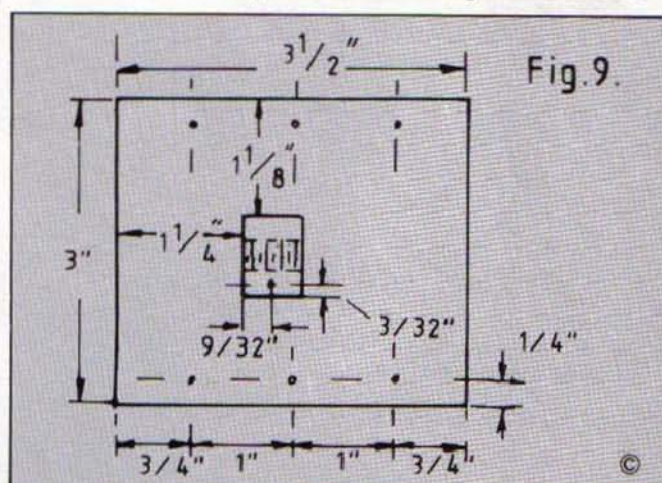
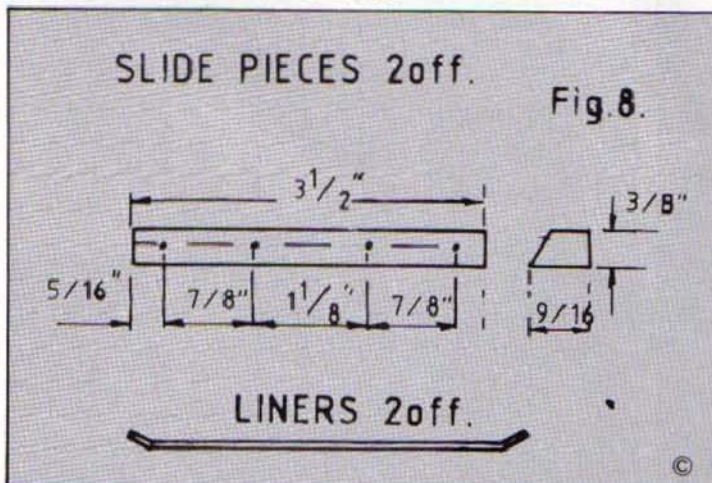
Cut two sections of hard steel. (Suggest T.N.8.) $\frac{1}{8}$ in. thick by $\frac{1}{8}$ in. wide and $\frac{3}{4}$ in. long. Turn out the ends as shown, cutting half way through and hard soldering. Polish the inside faces.

Top of slide, Figure 9

Cut section of BMS $\frac{3}{4}$ in. by 3 in. by $\frac{1}{8}$ in. thick and drill No. 32 of 2.9mm. as shown. Drill sliding block with No. 37 or 2.6 mm drill *One end only*. Position on the underside of the top plate as shown. Clamp the two together and mark through the hole in the sliding block. Take off the clamp and centre punch the underside of the top plate. Measure $\frac{1}{8}$ in. from this mark and punch mark for the second hole.

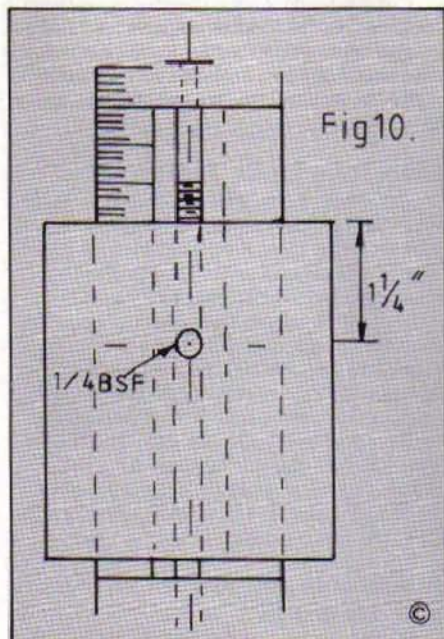
Drill both marks No. 37 or 2.6mm. Turn the plate over and open out the hole opposite the one already drilled in the sliding block with a clearance drill and countersink for a 5BA screw. Thread the hole in the sliding block 5BA. Screw on the sliding block to the approximate centre of the adjusting rod, and position in the end blocks and fasten down. Place the angled side pieces on each side of the main frame with the liners in between together with a thin paper - this is to ensure freedom of movement in the event of a slight discrepancy when fastening the top plate to the slides. Put the top plate on and screw through the one hole into the centre sliding block, making sure that the plate fits squarely over the slides. Secure with clamps and mark the slides through the drilled holes in the top plate. Remove the clamps, carefully punch the marks, and drill the slides No. 32 or 2.9mm. Tap 4BA, open out the holes in the top plate with a No. 26 or 3.7 mm drill and countersink. Attach to the slides and mark through the other centre hole into the sliding block with a No. 37 or 2.6mm drill. Dismantle and punch the mark, drill No. 37 or 2.6 mm and tap 5BA. (The reason for leaving this fastening until last is to make sure that there can be no mis-alignment in the adjusting screw and the centre sliding block.)

Fit the four adjusting screws in the side of each slide with a locking nut, the screws being just long enough to lock the slides when required. Screw the top plate to the slides, including the one in the middle. Measure $\frac{1}{8}$ in. from the front edge of the plate, as shown in **Figure 10**, and scribe a horizontal line. Attach to the lathe and adjust the slide until the line is on the centre line of the lathe, fitting a large head 5BA screw in the end hole of the adjusting rod for any reverse movement which may be required. Tighten the slide adjusting screws for rigidity and drill on the horizontal line with a centre drill held in the tailstock. Mark the turning piece on the top with a sharp scriber, also on the base frame opposite as a central register. Remove the



turning piece from the adjustment rod and attach to the mandrel already made. Place in the 3 jaw chuck and divide into 25 divisions, using a cutter set up in the slide rest. Use the mark already made on the turning piece as a starting point. Make this a long mark, also every fifth. The rest about half the length. Make the first mark a little thicker than the others.

Remove the turning piece from the mandrel and re-attach it to the adjusting rod. See that the first line made is opposite



the one on the base frame, and make a line with the scriber across the base in front of the top plate. Turn the turning piece clockwise 4 turns and make a short mark, carry on with the procedure making every fifth one all across the base, each division = $\frac{1}{5}$ in. The same method can be used at the other end of the slide, using the screw in the adjusting rod to move the slide back to the starting point. Mark this end in $\frac{1}{4}$ in. divisions making 5 turns for each mark. (Do not fasten the turning button with Loctite until all the work on the slide is finished.)

Centre Bearing

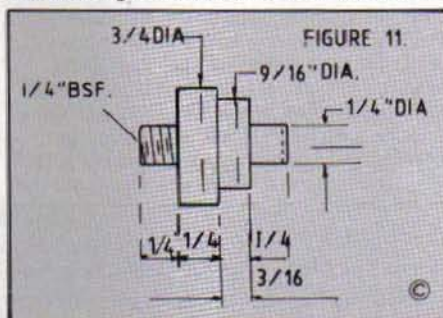
Make a wooden faceplate for the lathe about 5 in. in diameter and face true. Remove the top plate from the slide, and screw to the wooden faceplate, centring

with the tailstock centre in the drilled hole, and fastening in each corner with countersunk screws. Drill the centre hole No. 3 and tap $\frac{1}{4}$ in. BSF or equivalent. Remove the faceplate with the plate still attached and put on one side. Replace with the 3 jaw chuck and put in length of $\frac{1}{2}$ in. hexagon ms. Mark the side opposite No. 1 jaw. Drill No. 3 to a depth of about $\frac{1}{2}$ in. and tap $\frac{1}{4}$ in. BSF. Part off at $1\frac{1}{2}$ inch. (This is a temporary turning mandrel.) Remove from the chuck and replace with a piece of silver steel 1 in. or $\frac{1}{2}$ in. diameter of a length to allow $1\frac{1}{2}$ in. outside the jaws. Turn down the end for a length of $\frac{1}{4}$ in. to $\frac{1}{4}$ in. diameter and thread $\frac{1}{4}$ in. BSF.

Screw into the turning mandrel already made – be sure to relieve the thread so that it screws in fully and seats correctly – centre drill the opposite end and support with the tailstock, turning down close to the measurements shown in Figure 11, leaving a little to true up when attached to the top plate. Remove the bearing from temporary mandrel, and top plate from wood faceplate. Attach the bearing to the top plate, screwing up tight. Put the plate back onto the slides, making sure that the bearing is central and that all the screws are tight, including the slide-adjusting screws. Attach the assembly to the lathe and trim the bearing to size with a sharp tool, taking light cuts. Size the $\frac{1}{4}$ in. diameter by drilling and reaming $\frac{1}{4}$ in. diameter in a piece of scrap brass to be used as a gauge. Polish all diameters, and cut off the top to length and slot for a screwdriver.

Centre wheel "M" 120 teeth. 3 in. P.C.D. = Outside diameter 3.0675 in. $\frac{5}{16}$ in. thick, hard brass

Place in either 3 jaw or 4 jaw chuck in the lathe, a blank of sufficient diameter to allow truing to the correct size. Centre drill



and ream $\frac{1}{4}$ in. Put on to a stub arbor and turn down to a diameter of 3.0675 in. Cut 120 teeth with a circular or flycutter.

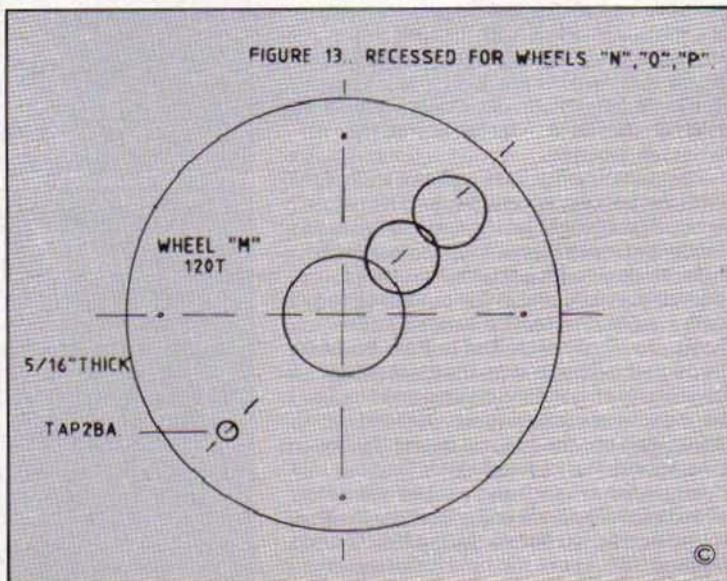
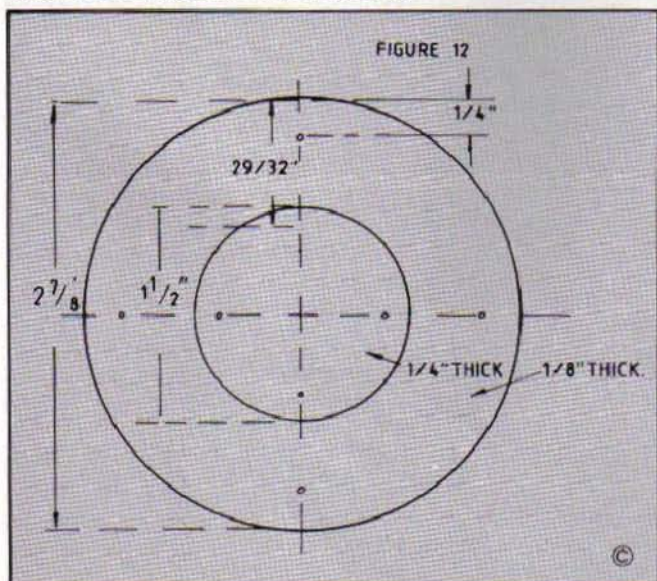
Large bearing – hard brass – Figure 12

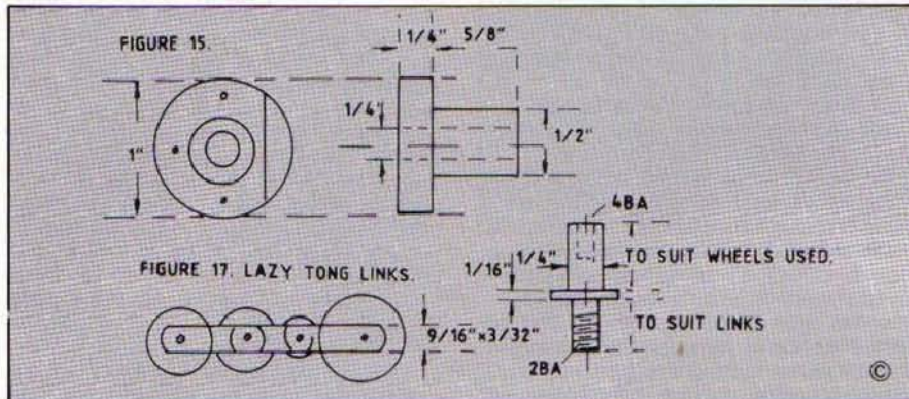
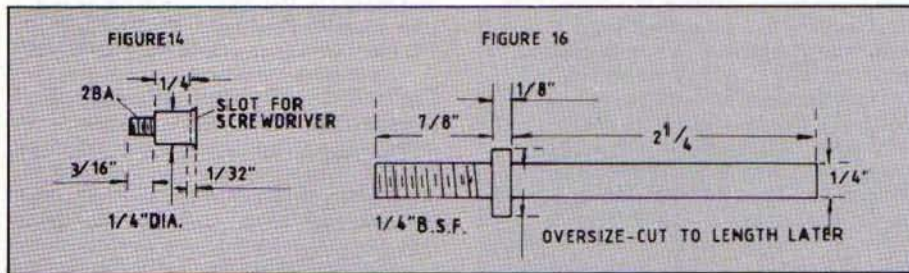
Centre drill brass blank $\frac{1}{4}$ in. thick by $1\frac{1}{8}$ in. diameter and ream $\frac{1}{4}$ in. Place on to stub arbor and turn down to $1\frac{1}{2}$ in. diameter. Do the same with a 3 in. diameter blank $\frac{1}{4}$ in. thick, reducing the diameter to $2\frac{1}{4}$ inch. Mark two lines across the face of the larger disc, through the middle and at right angles. Measure from the outside of the disc on each line $\frac{1}{4}$ in. and $\frac{3}{8}$ in., centre punch the 8 marks and drill No. 37. Place both small and large discs on $\frac{1}{4}$ in. Arbor. Clamp together and mark through the inner holes of the large plate on to the small one with a No. 37 drill. Remove the clamp, centre punch the marks, drill No. 37 and tap 5BA. Enlarge the holes for clearance in the large disc with a No. 30 drill and countersink.

Fasten the two discs together keeping a $\frac{1}{4}$ in. arbor through the centre holes while fastening. Any slight discrepancy in the screw holes can be corrected with a round needle file. It is essential that the centre holes line up accurately. Mark one of the screw holes on each disc with a punch to ensure correct reassembly. Follow the same procedure with the outer holes in the large disc and wheel M, making sure that screws fit without any distortion of the centre holes. Disconnect the two when satisfied all is well.

Wheels N,O,P

Cut two hard brass or preferably Phosphor Bronze wheels $\frac{1}{4}$ in. thick with $\frac{1}{4}$ in. centre hole. $\frac{1}{2}$ in. P.C.D. outside diameter 0.5675 with 20 teeth, and one the same thickness with 28 teeth outside diameter 0.7675 inch. Make a $\frac{1}{4}$ in. diameter centre punch from silver steel. Turn to a fairly flat point, harden and temper to blue. Put a $\frac{1}{4}$ in. arbor through the hole in wheel M and place the 28 tooth wheel N over the arbor. Position one of the 20 tooth wheels O in correct mesh with wheel N and punch mark the centre. Position the other 20 tooth wheel P in correct mesh with wheel O and punch mark as before. The marks to be equal distance between the fastening holes already drilled in wheel M as shown in Figure 13. Drill the two marks with a small drill, say No. 44.





Recesses for wheels N,O,P.

Screw wheel M to a wooden faceplate through the outside holes, using the tailstock centre to position centrally. Bore out centre hole to a diameter to allow ample clearance to the 28 tooth wheel N. Take out fastening screws and reposition with the first No. 44 hole as centre. Open out with a $\frac{1}{4}$ in. drill, then bore out to allow clearance for the 20 tooth wheel O. Deal with the recess for wheel P in the same way. Remove from the faceplate and drill and tap the retaining screw hole 2BA, as shown in Figure 13.

Attach the brass bearing to the wooden faceplate on a stub arbor in the same way used for wheel M with the smaller disc on the outside. Bore out the centre hole to a depth of $\frac{1}{4}$ in. to a diameter of $\frac{3}{8}$ in. using the steel centre arbor as a guide to a nice running fit. Bore out a further $\frac{1}{16}$ in. to a diameter of $\frac{9}{16}$ in. again using the arbor as a guide.

Screw the steel arbor tight into the top plate of the slide using Loctite or a similar retainer. Fasten the large brass bearing to wheel M and place over the centre arbor. Rotate the wheel-retaining hole over the top plate of the slide and mark through. Remove wheel M and the top plate, punch the mark and drill No. 22. Turn off the thread at the bottom of a hex headed 2BA screw to fit into the No. 22 drill size of a sufficient length to screw through wheel M and be adjustable to fasten or free the wheel as required.

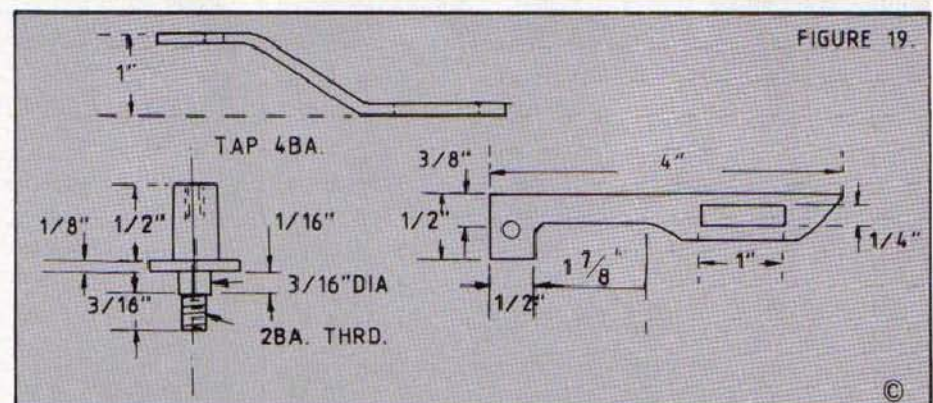
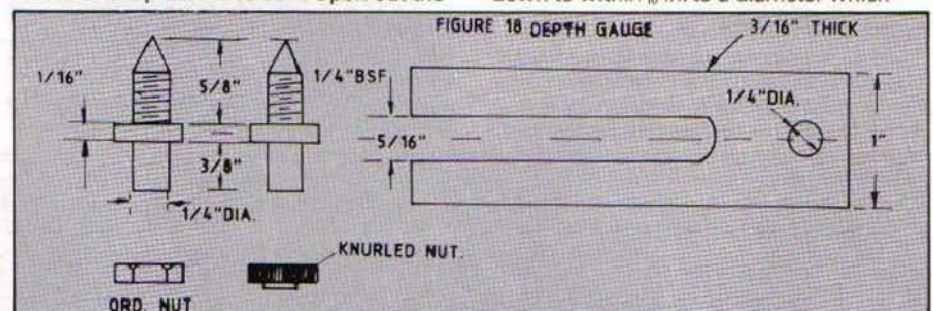
Reassemble the slide and place wheel M with the bearing attached over the central arbor. Put wheel M on the arbor (N with 28 teeth) and mesh wheel O, 20 teeth, punch mark through with a specially made $\frac{1}{4}$ in. diameter punch, and drill into the bearing with a small drill. Mark 3 equal distance holes around wheel N and drill No. 50. Mark through the 3 holes onto the steel arbor, carefully punch the marks and drill No. 50 for a depth of approximately $\frac{1}{2}$ in. and tap 8BA. Open out the holes in wheel N with clearance drill and countersink. Fasten down, mesh wheel O and check if the hole already drilled needs any adjustment with a round needle file before drilling No. 22 and tapping 2BA. Leave the hole for wheel P alone for the present.

Make the arbor for wheel O from silver steel as shown in Figure 14 to be a running fit.

Bearing for E and F wheels, Figure 15

Chuck in the 3 Jaw the 1 in. diameter hard brass, drill and ream $\frac{1}{4}$ in. diameter centre hole, turn the outside to the measurements shown and drill the 3 holes No. 37.

Cut off the side to allow room for the support bracket for H & G wheels. Drill the backplate $\frac{1}{4}$ in. diameter on the scribed line at right angles to and on the left side of the slide – with adjusting screw facing – $\frac{1}{8}$ in. from the outside edge of the backplate. Position the bearing with $\frac{1}{4}$ in. temporary arbor through the hole in the backplate, with the cut off portion nearest to the slide. Clamp and mark through the 3 holes in the bearing with a No. 37 drill. Remove the bearing and punch mark the backplate. Drill No. 37 and tap the holes 5BA. Open out the



holes in the bearing with a clearance drill and screw the bearing to the backplate.

Arbor to fit bearing and wheels E & F, Figure 16

Turn from $\frac{1}{2}$ in. silver steel to the dimensions shown, the $\frac{1}{4}$ in. diameter to be a running fit in the bearing without play.

Wheels F,G,H,J,K & L: from hard brass

Cut 3 wheels with 40 teeth $\frac{1}{4}$ in. thick, and one $\frac{1}{2}$ in. thick outside diameter 1.0675 in. also one with 60 teeth $\frac{1}{4}$ in. thick outside diameter 1.5675 in. and one with 28 teeth 0.7675 in. outside diameter. All centre holes to be reamed $\frac{1}{4}$ inch.

Lazy Tong Links, Figure 17

Cut these from Bright mild steel $\frac{7}{16}$ in. wide by $\frac{3}{32}$ in. thick, the one for the 40 tooth wheels to be $1\frac{1}{16}$ in. long. Punch mark one hole $\frac{1}{4}$ in. from one end. A depth gauge is now required to position the wheels in correct mesh before the other hole can be marked. I suggest one is made similar to Figure 18. Mark the other hole – using the gauge with the wheels correctly meshed – using a fine centre punch. Drill both holes with a small drill – say No. 44 – and follow with a No. 12 giving clearance for 2 BA. Stamp the number 40 on both ends of the link. Make links for No. 40 – 28 and No. 28 – 60 in the same way, and stamp to suit.

Adjustable support for wheels H & G, Figure 19

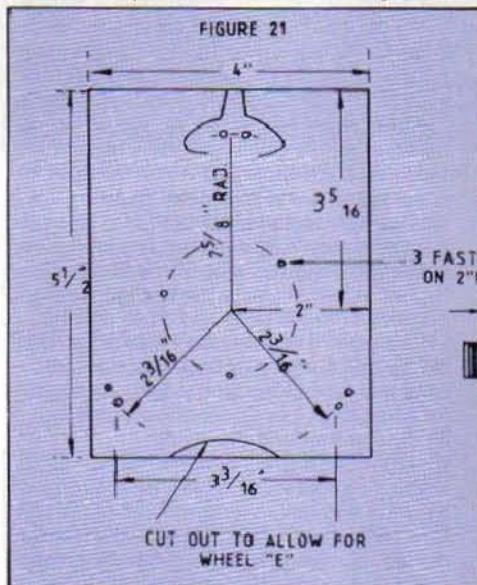
Use $\frac{1}{8}$ in. thick bright mild steel 4 in. long by $\frac{3}{8}$ in. wide. Cut to shape, and bend as shown. Heat will be required for this operation.

Arbor for adjustable support. Wheels G & H.

Turn down $\frac{1}{2}$ in. silver steel to fit holes in G & H wheels for a length to suit the thickness of the two wheels plus a slight turning tolerance. Drill the centre to a depth of $\frac{1}{4}$ in. approximately with No. 32 drill and tap 4 BA. Reverse in the chuck and turn down to within $\frac{1}{16}$ in. to a diameter which

ensures a tight fit in the support. Reduce the remainder to 0.185 in. and thread 2BA. Make the other Arbors required in the same way. Put the arbor made for wheels E & F through the bearings and backplate and place wheel F in position on the top. Fasten the arbor in the hole in the support and put on G the 40 tooth wheel. Position the support so that G & F engage correctly, making sure that it does not foul the adjusting screws on the slide. Scribe around the support slot onto the backplate. Centre punch to allow for 2BA tapping holes, one at each end of the slot. Drill No. 22 and tap 2BA, (the two holes allow for other wheels to be used when required.)

This completes the work necessary on



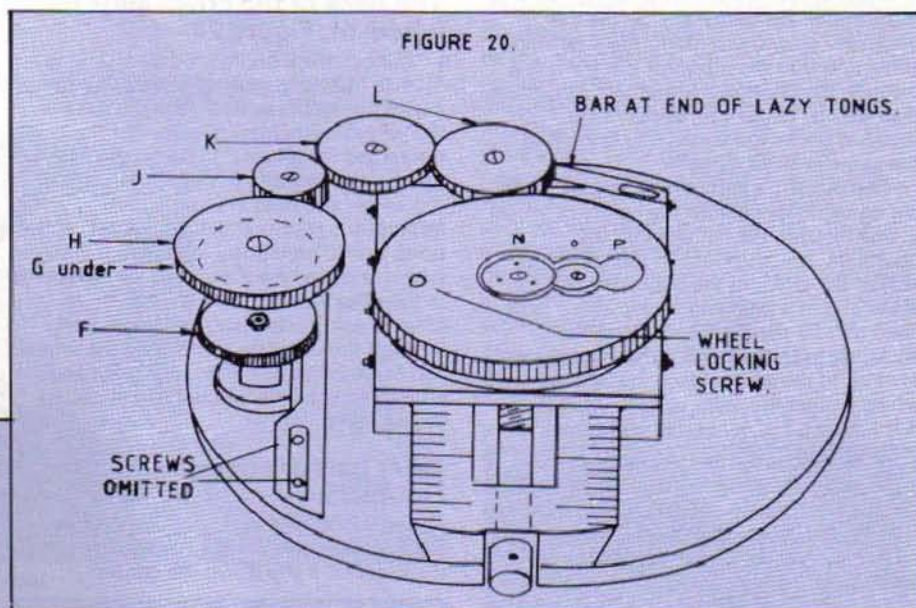
the front of the backplate for the present. Everything can be dismantled to allow the tumbler reverse on the back to be made. See Figure 20 for assembly.

Cutting gears and making tumbler reverse plate

Cut the main wheels A & E from hard brass 80 teeth 2.0675 in. diameter $\frac{1}{4}$ in. thick with $\frac{1}{4}$ in. centre reamed holes, also wheel D, 32 teeth, 0.8675 in. diameter and C & B 0.6675 in. diameter. Again with $\frac{1}{4}$ in. centre hole and $\frac{1}{4}$ in. thick. C & B to have 24 teeth. Leave a small rim on the bottom of the small wheels and countersink the tops. Turn up the 3 arbors from silver steel and slot the tops for a screwdriver.

Retaining disc

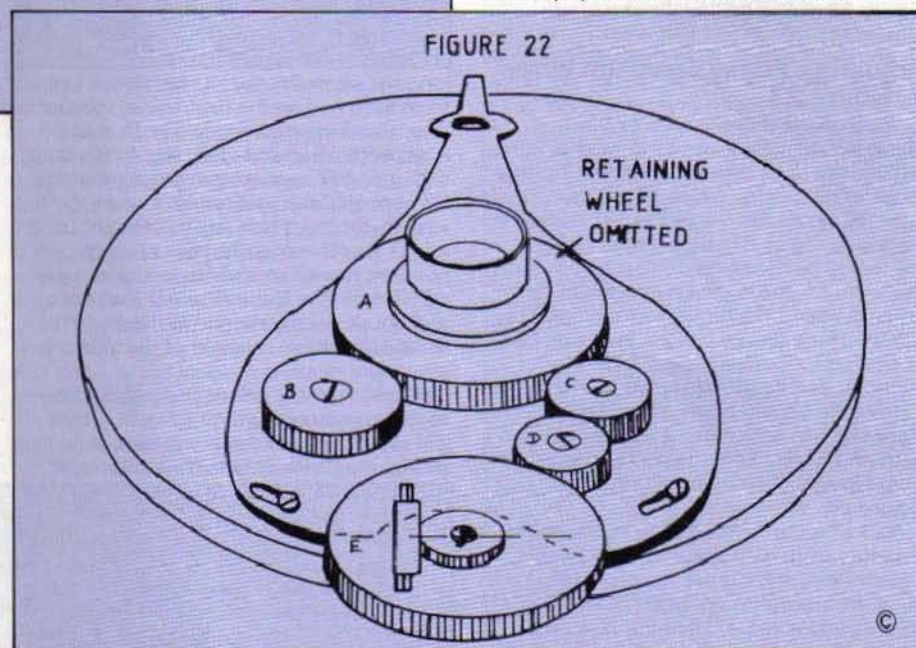
Cut bright mild steel plate $\frac{3}{4}$ in. thick $\times$ 3 in. square, scribe diagonally from each corner and centre punch the intersection. Scribe a circle from the centre $1\frac{1}{8}$ in. diameter. Centre punch where the line crosses the diagonals giving 4 marks to be drilled No. 37. Drill and ream the centre $\frac{1}{4}$ in. using a small drill to start the holes truly. Place the disc over wheel A on a $\frac{1}{4}$ in. arbor to ensure truth, clamp them together and mark through the 4 holes with a No. 37 drill. Separate and centre punch the marks carefully. Drill No. 37 and open out the holes in the disc with No. 27 drill and countersink. Do not tap the holes in wheel A as yet. Put the steel disc onto a stub arbor in the 3 jaw chuck and turn the outside to 3 in. diameter or slightly less, the diameter is not critical here. Turn the thickness down on the inside of the disc to $\frac{3}{8}$ in. from $1\frac{1}{8}$ in. diameter to the outside -



drilled and bore out to be a turning fit on the appropriate step on the Boss. Approximately $1\frac{1}{4}$ in. diameter. Tap the 4 holes in wheel A No. 5BA. Leave the wheel and disc apart for the present.

Tumbler Reverse Plate, Figure 21

Cut a section of $\frac{1}{4}$ in. thick bright mild steel $5\frac{1}{2}$ in. by 4 in. Mark $3\frac{5}{8}$ in. from the top of the plate and 2 in. from the side and centre pop where the two measurements



this is so that the edge of the disc will clear wheels D & C and the arbors. Scribe a line $\frac{3}{8}$ in. from the outside edge and mark 40 divisions around this line.

Remove from the stub arbor and carefully centre punch each mark, using an eyeglass to ensure accuracy. Drill with a stub centre drill and follow with a No. 28, removing any burrs. Place in 3 jaw chuck and open out the $\frac{1}{4}$ in. centre hole to a running fit on the Boss, approx. $1\frac{1}{8}$ in.

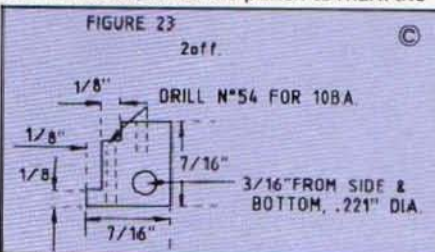
Wheel 'A'

To open out the $\frac{1}{4}$ in. centre hole in wheel A, turn out an insert in a hard wooden faceplate that the wheel will just tap into, using the tailstock centre to position correctly. Fasten through the holes already

meet. Mark out the other measurements shown, and the general outline of the plate. Centre punch the three equidistant holes on the 2 in. diameter circle and drill for small wood screws. Screw to a wooden faceplate using the tailstock centre in the centre pop to position correctly. Drill and bore out to fit the first step on the Boss and remove from the lathe. Drill the two holes on the $2\frac{3}{8}$ in. radius $3\frac{5}{8}$ in. apart at the bottom of the plate with a No. 12 clearance drill for 2BA. At $\frac{1}{4}$ in. on the outside of these holes, still on the same radius, drill another two holes, and join up to form a slot on either side of the plate. Carry out the same procedure at the top, then shape the outside of the plate, the dimensions not being critical.

Place wheel A over the Boss followed by the Tumbler Reverse Plate. Screw the backplate on without fitting the 4 retaining screws, and fit the arbor for E & F wheels through the bearing – a washer $\frac{1}{8}$ in. outside diameter by about $\frac{1}{8}$ in. thick will be required under the wheel E to bring it to the same level as wheel A.

See that the tumbler reverse plate slots are equal distance from the centre of wheel E. Drill through the left slot into the backplate, keeping close to the left-hand side of the slot. Tap the backplate 2BA. Make and fit a retaining screw with a large head to hold the Reverse plate to the backplate with the left-hand side of the slot hard up to the screw. Place the 32 tooth wheel so that the teeth engage wheel A & E. Use a $\frac{1}{8}$ in. centre punch to mark the



tumbler reverse plate, drilling and tapping 2BA. Fasten with one of the arbors already made. Now push the tumble reverse plate over to disengage the wheel teeth with the screw up to the right-hand side of the slot. Position the other two small wheels in a like manner so as to engage A & E wheels, adjusting the slots by filing if necessary. Figure 22 shows the details of this sub-assembly.

Adjusting Phase screw on wheel E, Figure 23

Place in the three-jaw chuck $\frac{1}{2}$ in. diameter silver steel around 4 in. long, leave outside the jaws about 2 in. to clear turning tool. Centre drill for support from the tailstock centre. Turn down to $\frac{3}{8}$ in. diameter for a distance of $1\frac{1}{4}$ in. and thread 12 TPI – the tool to be the same dimensions as the one used for cutting the wheel teeth. Turn off each end of the thread to a diameter of 0.221 in. for a distance of $\frac{1}{8}$ in. using a piece of scrap brass with a hole of 0.221 in. diameter as a gauge to ensure a nice running fit. Square both ends to take a clock key $\frac{1}{8}$ in. square for a length of $\frac{1}{4}$ in. at each end. Make the end support pieces from $\frac{1}{8}$ in. thick hard brass as shown in Figure 23.

Cut 24 tooth wheel 0.6675 in. outside diameter from hard brass for the phase adjuster and drill a cross-hole for the pin. Push the arbor through bearing, fit the washer and wheel E. Then the 24 tooth wheel. Mark through the pin hole in order to drill the arbor correctly for the pin.

Place the phase screw with the bearings at each end and support with clamps, making sure it engages correctly with the 24 tooth wheel. Mark through the screw holes onto wheel E. Drill and tap 10BA. Open out the holes in the supports for clearance and screw down. Fit and screw a thin piece of brass across the top.

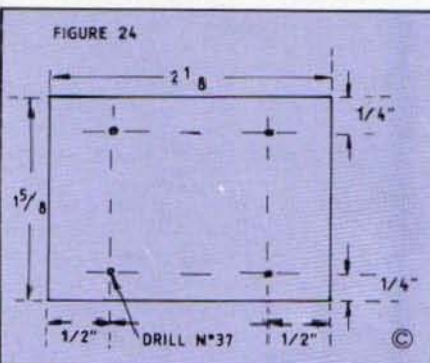
After making sure that the tumbler reverse and the phase wheel work smoothly then all the parts already made can be assembled, including the retaining plate on wheel A. This must clear the arbors of the small wheels, and they must allow free movement without play of the tumbler reverse plate. A little Loctite on the threads is necessary here, and on the retaining screws.

The base of the cross-slide on wheel M, Figure 24

Cut $\frac{1}{2}$ in. thick bright mild steel $2\frac{1}{2}$ in. by $1\frac{1}{8}$ in. to fit across wheel M, rounding the corners as necessary to clear the base of the wheel teeth. Mark the front of the plate, the recess for wheel P to be on the left-hand side. Place the plate centrally across the wheel and hold in place with a toolmaker's clamp. Drill through two of the holes drilled previously in the plate, into the wheel and tap 5BA. Open out the two holes in the plate with No. 30 drill and countersink. Fasten plate to wheel. Drill through the other two holes into the wheel. Tap these holes as before, open out and countersink the plate holes and fasten to the wheel.

Inner part of cross-slide, Figure 25

Cut a length of steel. I would suggest E.N.8 steel or similar, $2\frac{1}{2}$ in. by 1 in. by $\frac{1}{4}$ in. thick. Scribe a line down the centre



lengthwise, and make a punch mark $\frac{1}{8}$ in. from each end on the centre line, then at intervals of approximately $\frac{1}{8}$ in. Drill all 8 holes with small drill – say No. 45 – follow with $\frac{1}{8}$ in. drill, connect up the holes with a file to form a slot just over $\frac{1}{8}$ in. wide. Be sure that the slot is in line with the outside edges, that it is true, and has smooth polished faces. Cut a sliding block as per sketch from the same material. File, stone, and polish, for a sliding fit in the slot. (This should slide from one end of the slot to the other with no play.)

Carefully mark and centre punch the centre at each end and drill No. 51 – this will allow a standard piece of blue steel to slide through. Fasten the sliding block at

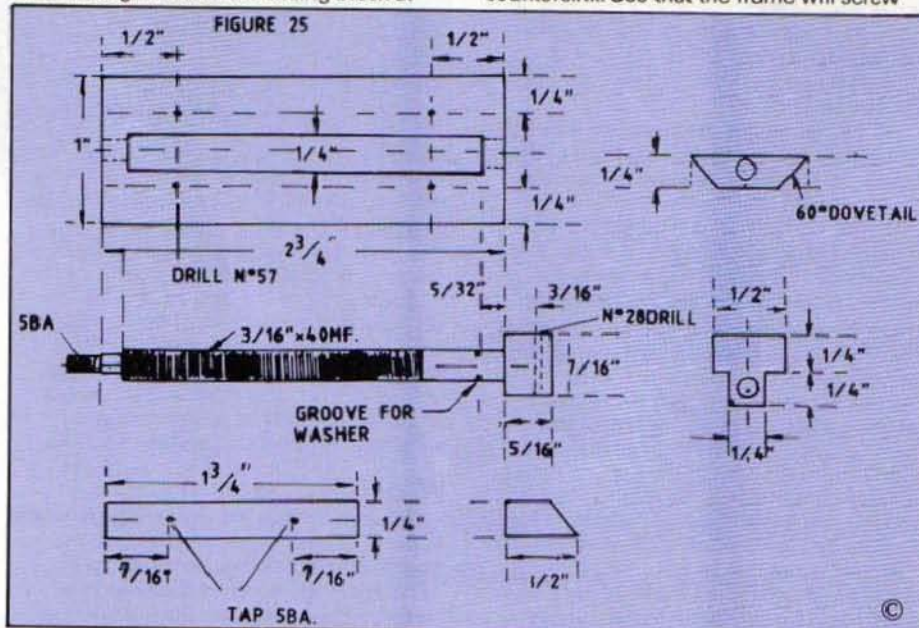
one end with clamp and drill into this through the end of the slot. Try the blue steel through with the block in position. Be sure of a sliding fit from one end to the other, using a needle file to true up any hole which is out of true. Accuracy is essential here.

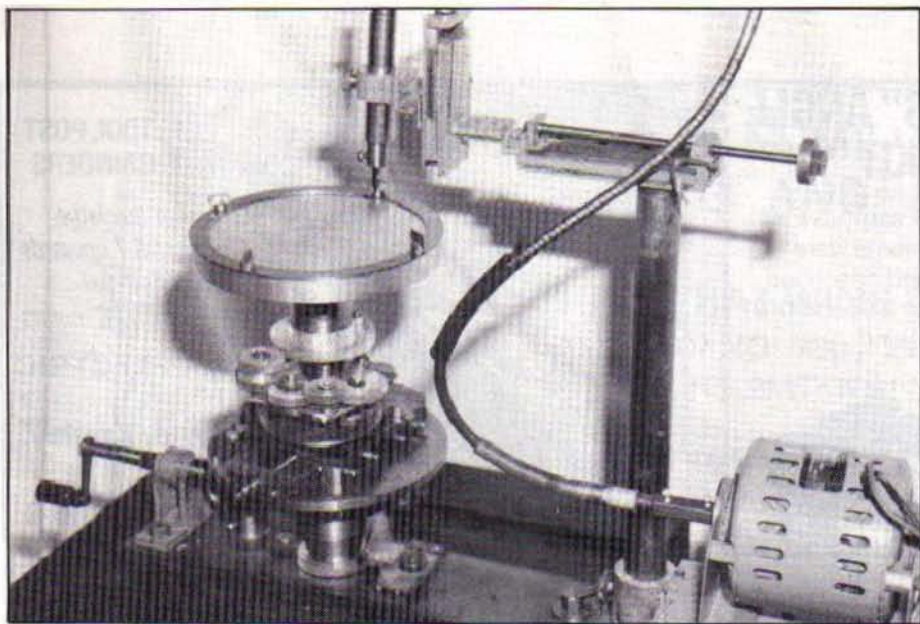
Open out the hole in the front end of the slot to $\frac{3}{8}$ in. diameter and the other end to No. 30 size 0.128 in. Also the hole in the sliding with a No. 20 drill and tap $\times 40$ TPI $\frac{1}{8}$ in.

Adjusting screw

Put about 4 in. of $\frac{1}{2}$ in. A/F hexagon bright mild steel in the three-jaw chuck leaving 1 in. outside the jaws. Turn down $\frac{1}{2}$ in. to be a running fit in the 0.128 in. hole at one end of the slot. File a point on the end while in the lathe, then reduce the diameter for a length of $\frac{1}{4}$ in. – not including the cone to 0.126 in. and thread 5BA. Draw out the rod from the chuck about one inch, maintaining the same position relevant to the jaws, and supporting with a tailstock hollow centre, and turn down to $\frac{3}{8}$ in. diameter. Repeat until a length of approximately $2\frac{1}{2}$ in. has been reduced – check with length of slot – Thread 40 TPI by $\frac{3}{8}$ in. to within $\frac{1}{8}$ in. of the hexagon end. Remove from the lathe and cross drill the $\frac{1}{2}$ in. hexagon $\frac{3}{8}$ in. from the inside edge with No. 28 drill (for tommy bar). Replace in the lathe and turn of the flats to $\frac{1}{8}$ in. diameter for a length of $\frac{1}{8}$ in. Divide this portion into 25 divisions around the inside circumference, every 5th division being longer than the rest. Part off. Try the rod in the slide and mark inside the end of the slot for a retaining washer, cut a shallow groove in the rod, making sure there can be no end play. Mark a datum line on the top of the frame to match one of the divisions on the turning piece. Put the rod through the $\frac{3}{8}$ in. hole in the frame and screw into the sliding block, screw a 5BA nut onto the end of the rod and cross drill with a No. 57 drill. Leave the fitting of the pin until later.

Place the frame over the base on wheel M on a centre line. See that the turning piece will clear wheel F at the front, and that the aperture for wheel P is on the left of the slide. Fasten with clamps and mark through the 4 fastening holes. Carefully punch the marks and drill No. 57 size. Tap 8BA, open out the holes in the frame and countersink. See that the frame will screw



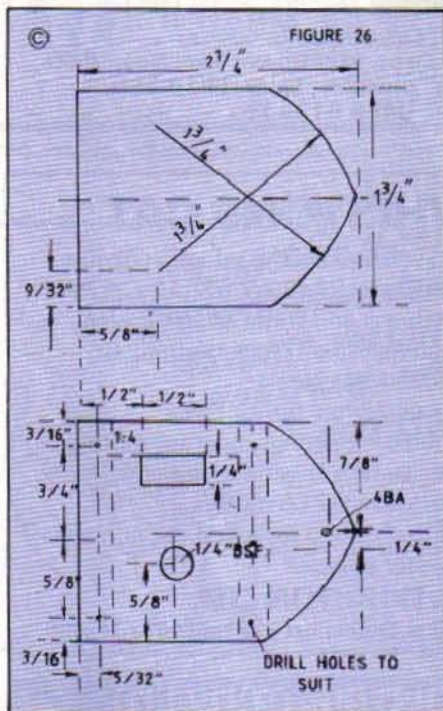


The chuck shown with engraving stand and tool.

down correctly. Remove the frame and the adjusting rod and mark a 60 deg. dovetail on each long edge, the wider portion being on the top. Cut and file to shape using a 60 deg. gauge during filing.

Sliding sidepieces

Use the same size material as used for the centre frame, 1 in. wide by $1\frac{1}{2}$ in. long. Cut and file both long edges to 60 deg. to



match the centre frame, place both sections on a piece of plate glass and rub the sloping pieces together using a coarse grinding paste to start with, follow with a fine paste until the two faces are a smooth fit. Mark one piece to locate correctly afterwards. Cut the 1 in. section down the middle to form the two slides and file smooth. Now drill the right-hand side for the adjusting screws No. 37 and tap 5BA.

Top plate of slide, Figure 26

Cut $\frac{3}{16}$ in. thick bright mild steel $1\frac{1}{2}$ in. by 2 in. Cut out the slot for sliding block as shown, make sure the block is a press fit with no play in any direction. To ensure that the plate will slide over the retaining

washer on the adjusting screw, a semicircular groove is necessary under the front of the plate. This can be cut with a rotary file in the drilling machine for a distance from the front edge of $\frac{1}{4}$ in. The finishing off being done with a semicircular file.

To fasten the side sliding pieces $6 \times \text{No. 37}$ holes are required, also a No. 32 hole should be drilled in the plate at the same time and tapped 4BA as shown. This is a fastening for the end of the lazy tongs. An adjusting slip can be made from an old junior hacksaw blade, with the teeth ground off. Heat each end and bend over to prevent movement. Polish the sliding surfaces.

Place the top plate over the centre block and the left-hand slide. Clamp firmly and mark through the three holes with a No. 37 drill, remove, carefully punch each mark, drill and tap 5BA. Open out the three holes in the top plate with a No. 30 drill and countersink, insert the three screws and tighten. Place the other slide with adjusting slip in position and clamp firmly.

Mark through the holes, centre punch, and drill and tap as before. Finally put in the adjusting screws with the locking nuts into the side of the right-hand slide. Dismantle the fitting from wheel M.

Remove the thread from the end of a 2BA hexagon screw, to screw through the tapped hole in wheel M and into the plain hole in the top plate of the bottom slide, leaving sufficient clearance when released for the head of the screw to miss the top slide. This is so that when the screw is turned down, wheel M will move round with the backplate to find the centre of the top slide in the lathe. This also allows it to be fastened as required when drawing or cutting patterns.

Fasten wheel N with the three screws, using a thin washer underneath if necessary to make fast, and fit a hexagon screw through wheel M and into the top plate of the bottom slide to ensure propulsion. Scribe a line across the top plate of the top slide $\frac{1}{2}$ in. from the front edge as a guide for the position of the centre hole. Fit the top slide baseplate to wheel M and assemble the slide with the adjusting rod. Screw the whole chuck onto the lathe mandrel, and place a centre drill in the tailstock. Adjust the slide so that the centre drill is on the scribed line $\frac{1}{2}$ in. from the front of the plate, and one of the long

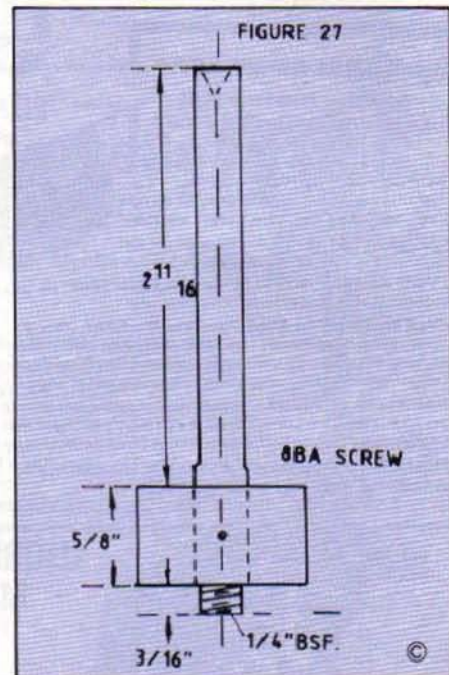
marks on the turning adjuster is opposite the datum mark made on the frame. Make certain all fastenings are tight. Drill with the centre drill to about half the thickness of the plate. Remove the whole assembly from the lathe. Take off the top plate and place in the 4 jaw chuck in the lathe adjusting the jaws so that the centre drill will fit perfectly into the hole drilled. Replace the centre drill with a No. 3 and drill through plate and tap $\frac{1}{4}$ in. B.S.F. with the plate still in the chuck. Screw plate back onto slide. Do not move the adjusting screw until all work above the slide is finished.

Centre spindle for top slide, Figure 27

Take a piece of silver steel $3\frac{1}{2}$ in. long. Place in 3 jaw chuck and centre drill one end. Turn end for end, keeping position relevant to the jaws, and reduce to $\frac{1}{4}$ in. diameter for a distance equal to the thickness of the top slide plate. Thread $\frac{1}{4}$ in. B.S.F. and relieve the thread slightly at the inner end to ensure a perfect upright fit in the hole. After fitting, place the whole mechanism in the lathe – again making sure that all fastenings are tight – with the rod being supported by a small tailstock centre. Reduce the diameter of the rod to just under $\frac{1}{8}$ in. except the last $\frac{1}{2}$ in. at the headstock end which should be exactly $\frac{1}{8}$ in.

Steel centre bearing, Figure 27

Chuck a piece of silver steel $1\frac{1}{2}$ in. or $1\frac{1}{4}$ in. diameter of sufficient length to allow at least 1 in. outside the jaws. Drill centre hole $\frac{1}{4}$ in. diameter to a depth of $1\frac{1}{2}$ in., open out with a boring tool to $\frac{1}{8}$ in. diameter to be a press fit on the $\frac{1}{8}$ in. diameter portion of the rod. Face true, and part off at just over $\frac{1}{2}$ in. long, leaving a little to true to dead



size later. Remove the top plate from the slide, and press the bearing onto the rod with the true face next to the plate. Clamp together and drill a cross-hole through the bearing and into the rod with a No. 50 drill and tap 8BA. Countersink sufficient to sink the top of the 8BA screw slightly. Insert the screw with a little Loctite. Put this on one side for the present.

This feature will be concluded in Part 2 in the next issue.



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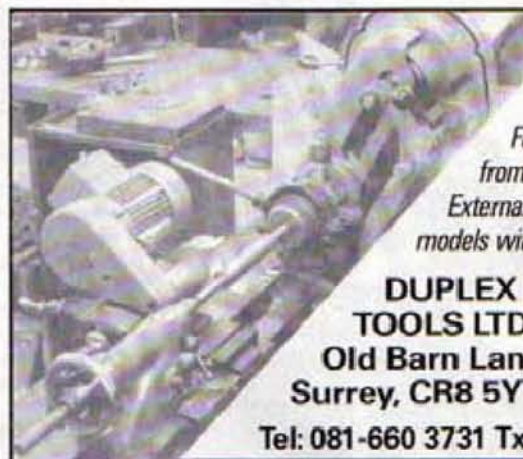
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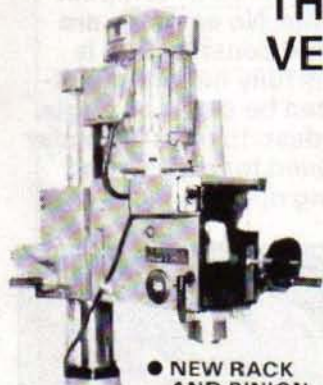
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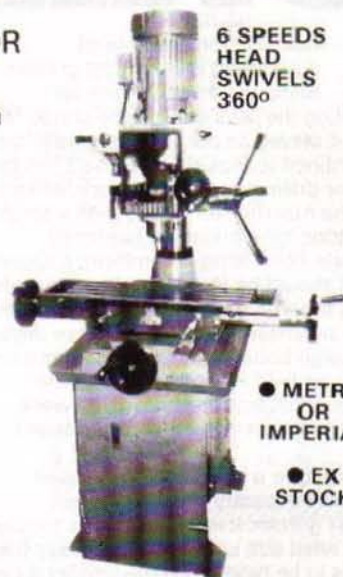


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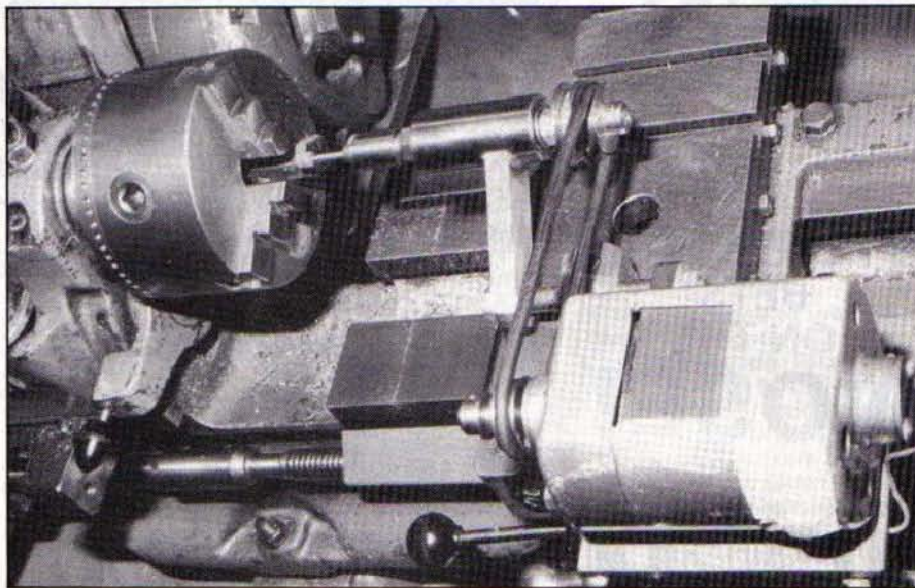


A TOOL POST GRINDER

This delightful little grinder from "Bluey" is both compact and versatile. No castings are required and construction is simple. It is fully height adjustable and can be set at an angle. Although described as a grinder it can be used for drilling and light milling operations as well

A not so common piece of equipment is a toolpost grinder. Mine was initially made for regrounding the jaws of the lathe chuck, for which it served its purpose very well. It is not confined to that, however, as it can be used for drilling and milling work held on the lathe mandrel, as well as with a small grindstone for working on hardened materials. For drilling and milling, a speed control should be fitted, and for those who are not keen on electronics such controllers can be purchased quite easily these days. The design bolts to the cross slide as a rule, but can be held in the toolpost on the compound slide to enable angled work such as regrounding centres to be carried out.

I only have a small lathe and it was therefore necessary to make a small toolpost grinder. It is fairly obvious that, no matter what size lathe the reader may have, if one is to be made then the smaller it can be built whilst remaining efficient the better it will be, as it leaves greater room for the operator to work in. The grinder is fully height adjustable and therefore would work on the majority of lathes found in the home workshop. This does not mean that those who wish to, cannot make a larger model if



Overall photograph of the assembly including the motor. This shows clearly how compact the unit is, leaving plenty of room for working purposes.

the race being 7mm, and are double shielded.

A small flat filed or milled at the point where the two parts meet would also help improve the appearance.

The bearing housing

The bearing housing can be from a piece of one inch diameter bright mild steel bored through to half inch diameter. Recesses are machined at either end 22 mm diameter and 7 mm deep. The diameter of the recess should be done as accurately as possible to prevent any sloppiness in the bearing fit. It will be seen that a bracket fits to the housing, and in my case this was welded on taking care not to cause distortion. If suitable welding equipment is not available, the housing can be drilled and tapped and a thread turned on the end of the bracket to allow it to screw in and then be held with a retaining compound such as Loctite 601.

Fixing the bracket to the bearing housing

The welded construction allows the bracket to be shaped neatly to fit round the housing prior to welding; this will not be possible with the screwed construction and there will not be a great deal of metal for the thread to take on up on. It might therefore be advisable to use a slightly thicker bar for the housing, say 1½ in. diameter, which will give a better thread depth. A ¾ in. thread such as 2BA can be used. There will be a rather unsightly gap at the join and this can be filled with epoxy adhesive or Plastic Padding and filed to shape when set.

The spindle bracket and bearing housing.



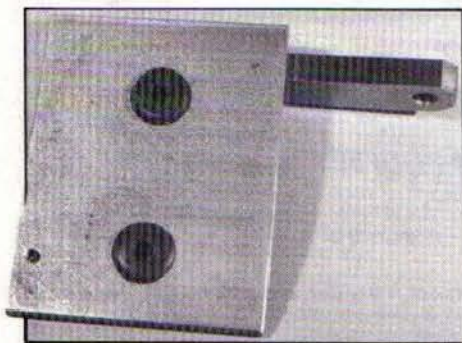
The spindle

The spindle on the one illustrated was made from ½ in. Whitworth Hexagon mild steel bar. With a size like that, it goes without saying that it was a piece that was around the workshop, and readers are unlikely to find the same material. It is no problem, as ¾ in. or 14 mm A/F mild steel will do just as well and is easy enough to obtain. All operations were carried out from one end in the interest of accuracy. Start by boring the recess ¾ in. diameter and ½ in. deep, countersinking it to a diameter of 13/32 in. diameter. A centre can now be used to support the work; this must be either a hard centre or, better still, a revolving one as per the description in the last issue.

The remainder of the spindle can now be machined, leaving only the 5/16 in. diameter thread to complete. It can be parted off a little overlength, and reversed in the chuck to be gripped by the hexagon. A little tip here: even if the chuck is a bit out of true, if the flat of the hexagon in number one jaw is marked, when the work is taken out and the same flat is inserted in the same jaw, the work will still be running true. The work can now be machined to length and threaded. The flat can either be filed or milled.

The collet holder

This was made from 3/8 in. diameter bright mild steel. Industrial collets are made from high carbon steel and are hardened and tempered. This is not necessary for those used in the home workshop as a rule. Face the end, centre and drill 3/32 in. diameter by 1½ in. deep. Next bore 3/32 in. diameter by ¾ in.

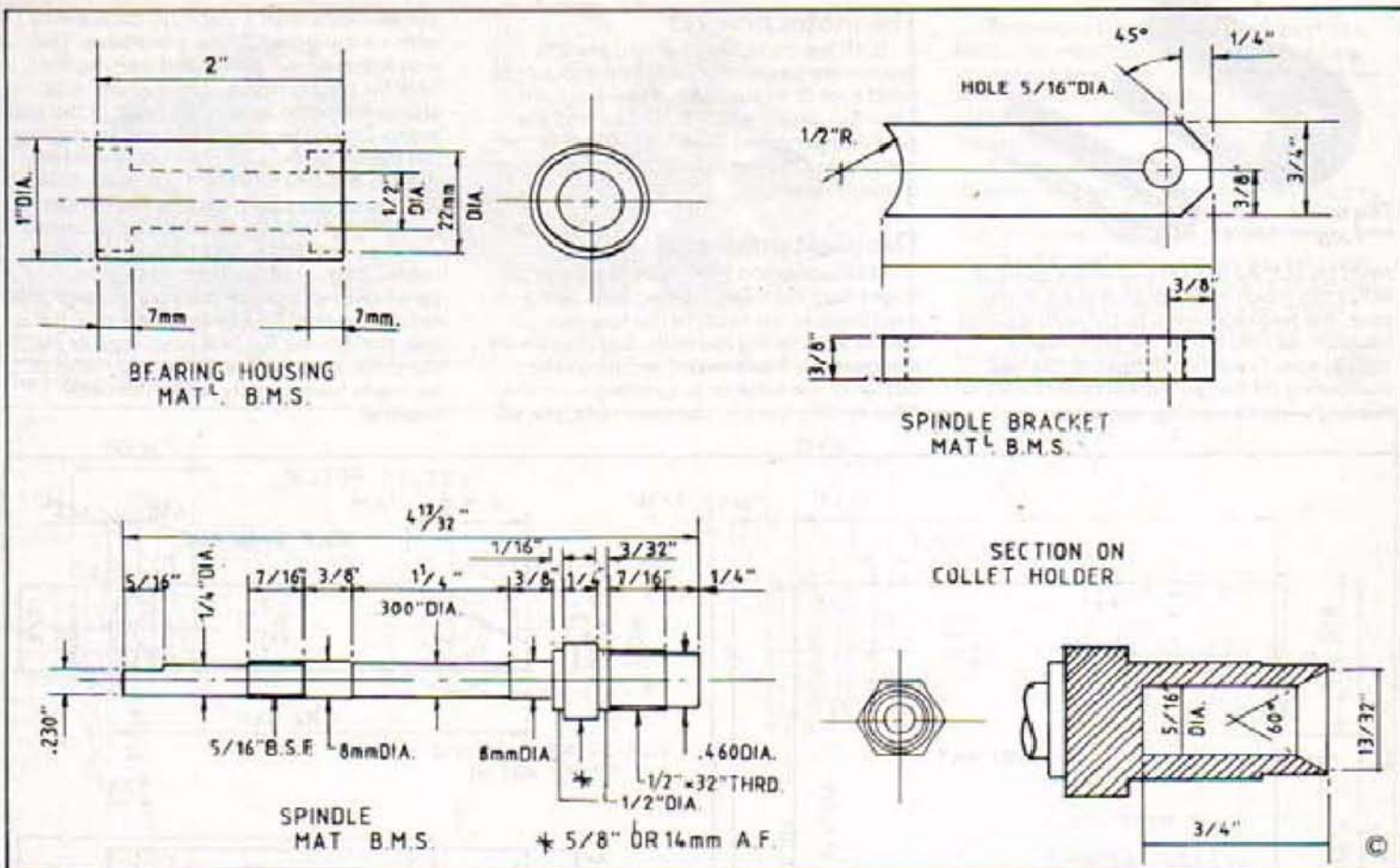


The motor bracket. Note the rubber grommets which made ideal motor mountings.

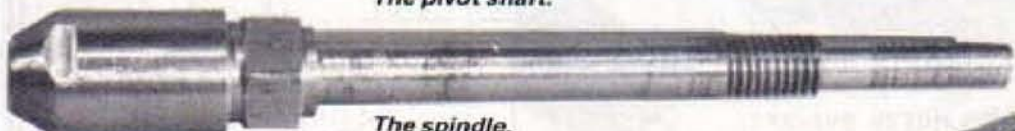
they wish; there are no complicated parts to make, and scaling the device up would be very easy.

The bearings

The manufacture of all parts is very straightforward but before starting, it is necessary to obtain a pair of double shielded ball races. This only means ball races with covers over the balls at each end. The size of these will determine, to some extent, the size of the finished article. Do not get ones that are too small, however, as that will mean a reduction in the collet size. In my usual way, the races used were obtained from some obscure source and are of an odd size – the sizes quoted therefore have been altered to fit standard races. The ones I would suggest are type 6082; they are 22mm outside diameter and 8mm bore, the width across



The pivot shaft.



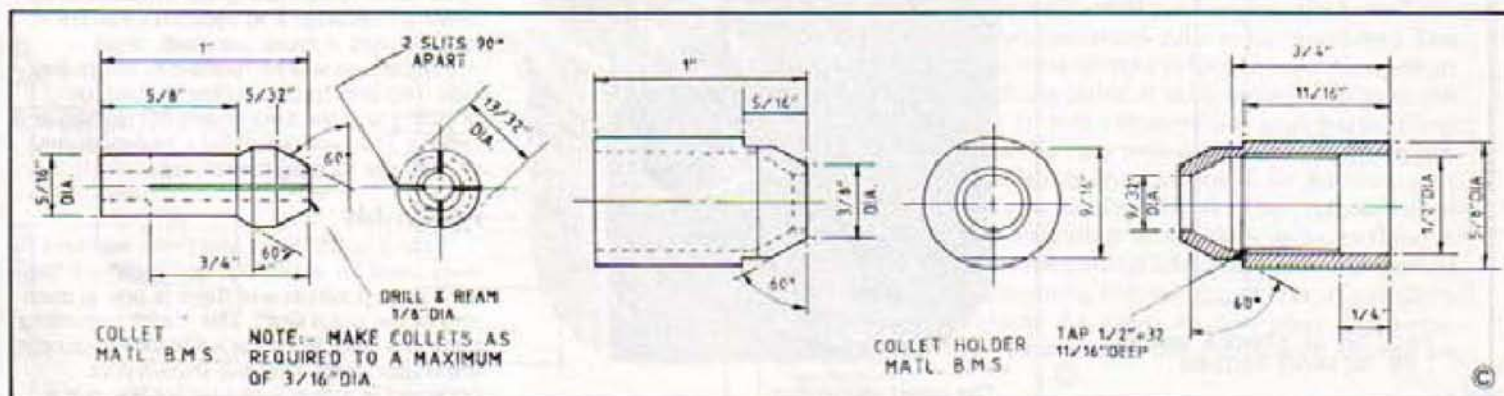
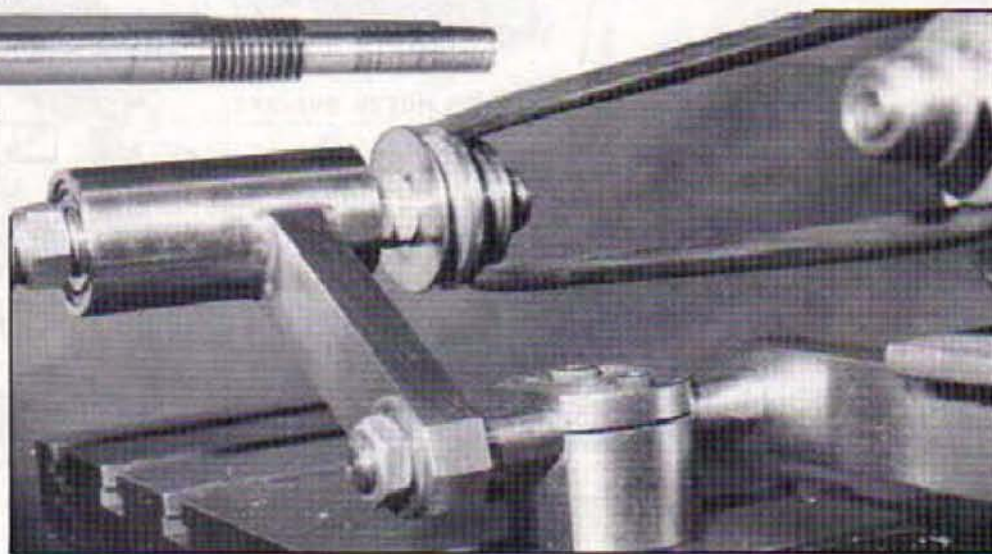
The spindle.

deep. Use a BS5 centre drill and countersink to the full depth of the centre drill. Tap $\frac{1}{2}$ in. by 32 TPI, $\frac{1}{2}$ in. deep and remove the first $\frac{1}{2}$ in. of thread. Part or cut off, reverse in the chuck and clean up to size. Machine a sixty degree angle to $\frac{1}{2}$ in. diameter. Two flats can be filed or milled opposite each other.

The collets

The collets are also made of bright mild steel, $\frac{1}{2}$ in. diameter. All the machining operations were carried out at one setting with the tapered section outermost from

A view of the assembly showing how simple the construction is.





The collet and collet holder.

must be carried out very carefully as there is not too much material to grip on. In my case, the two slots were put in with a junior hacksaw as I did not at the time have a slitting saw. There is a danger of the saw wandering off line so a great deal of care is needed with the sawing operation.

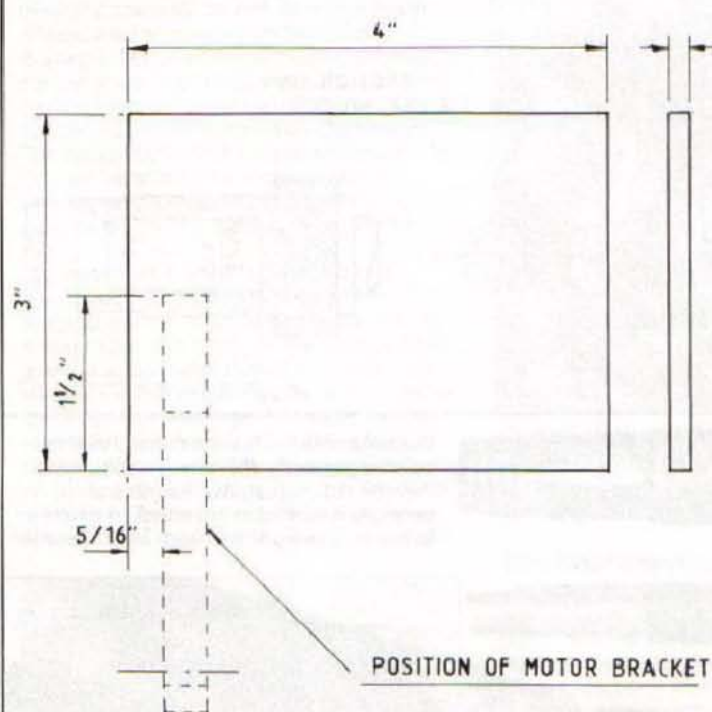
The motor bracket

Both the motor bracket and spindle bracket are straightforward and should not need a lot of explanation. They are from $\frac{3}{4}$ in. $\times$ $\frac{3}{8}$ in. bright mild steel strip, and are simple drilling and filing jobs. There is nothing too critical about the measurements.

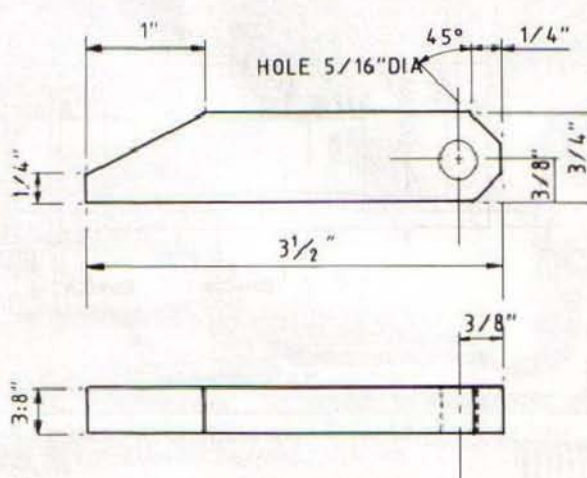
The pivot mounting

This was made from $1\frac{1}{4}$ in. diameter bright mild steel bar, the two flats being machined, in my case, in the four-jaw chuck, after facing the ends, but they could just as easily been milled, either on the saddle of the lathe or in a milling machine. After drilling the $\frac{3}{4}$ in. diameter hole, the slit

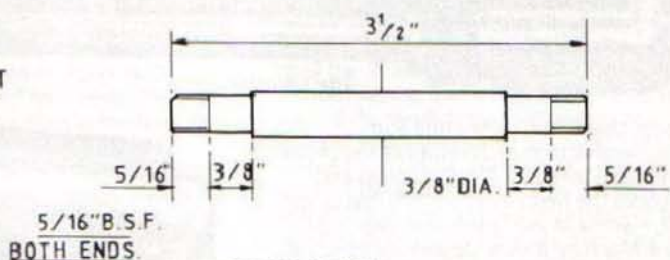
can be made with a standard hacksaw or with a slitting saw if one is available. This was followed by drilling and tapping the hole for the clamping screw, which was also recessed to accept the head of the cap screw. Finish the component off by drilling the clearance hole for the bolt which fits the Tee nut and secures the grinder to the lathe, and recessing it for the cap screw head. This is shown as 2BA, as that suited my lathe but it may well be that, for other lathes, a larger diameter is needed. It may be advisable to check that room is available before starting the component since, if the bolt that fits the tee bolt is as large as $\frac{3}{8}$ in. diameter, then the mounting may have to be made from slightly larger diameter material.



MOTOR MOUNTING PLATE
MAT BLACK PLATE.

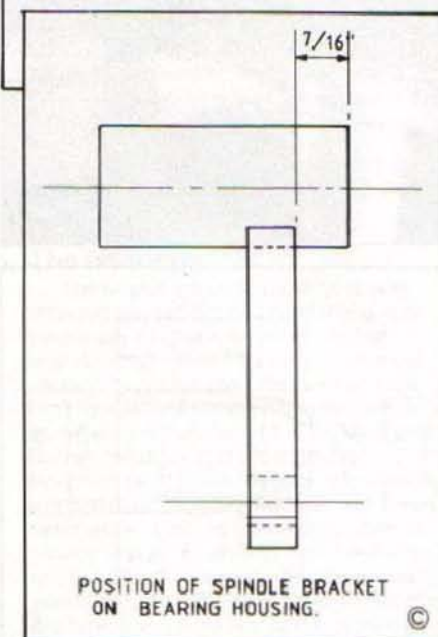


MOTOR BRACKET
MAT B.M.S.



5/16" B.S.F.
BOTH ENDS.

PIVOT SHAFT
MAT B.M.S.



POSITION OF SPINDLE BRACKET
ON BEARING HOUSING.



The pivot mounting.

The pulleys

The pulleys were made to take an available round neoprene belt, $\frac{3}{8}$ in. diameter, which is an 'O' ring $\frac{1}{2}$ in. diameter. This is a standard size but other belts worth considering are those used for sewing machines and vacuum cleaners. It may be that, if these are used, slight modifications will be needed to the pulley size. The one-to-one pulley is used for grinding and the two-to-one for drilling and milling. The work involved consists purely of ordinary turning operations.

Assembly

Four $\frac{5}{16}$ in. BSF nuts and three washers were used for assembly. Two nuts lock the spindle in position and there is one at each end of the pivot shaft. The motor mounting plate will have to be varied in size to accept the motor used. The one shown was obtained at a club junk sale for 35p but a

A TOOLMAKER'S

Continuing the policy of articles of overall workshop interest we offer readers these instructions for making a cabinet of the type known as a toolmaker's cabinet. Designed mainly for marking out equipment the constructional methods could be adapted for other small storage cabinets as well; using only standard materials there is little cutting to be done and readers making it will be amazed at just how easy it is

This is a plan of a simple toolmaker's cabinet; those who have been in the engineering industry will have no difficulty in recognising it. Such a cabinet was always the proud possession of the skilled craftsman, and the toolroom apprentice looked forward to getting one in which to keep his personal marking-out equipment. That was the purpose to which they were mainly put, the drawers being suitable in size for the necessary tools. Leaving marking-out tools around the workshop was never the thing to do — others might well take a fancy to them and, that apart, they were likely to get damaged and possibly rusty as well.

The cabinet shown follows closely the pattern of one made some fifty odd years ago, but the drawer arrangement has been altered. The small drawers would be used for items such as thread gauges, etc. The longer ones would hold calipers, dividers, a ruler or two, plus scribes and a centre or possibly a marking-out punch, and, if the owner possessed such a thing, a vernier caliper as well. The larger drawer at the bottom held the highly prized vernier height gauge and possibly a scribing block, while the small deep drawer would hold micrometers.

The actual construction of the cabinet is remarkably easy and the drawers can be made from standard sized hardwood strip which is available from almost any do-it-yourself shop. It will be seen that small grooving joints are suggested as a means

of joining the wood. These can be made on a milling machine, or on a lathe with the wood clamped against an angle plate on the cross slide, and a milling cutter held in the chuck.

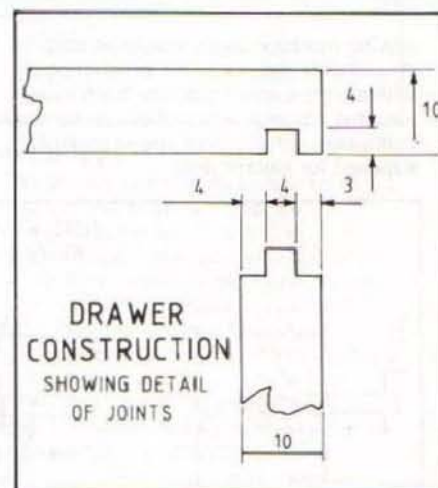
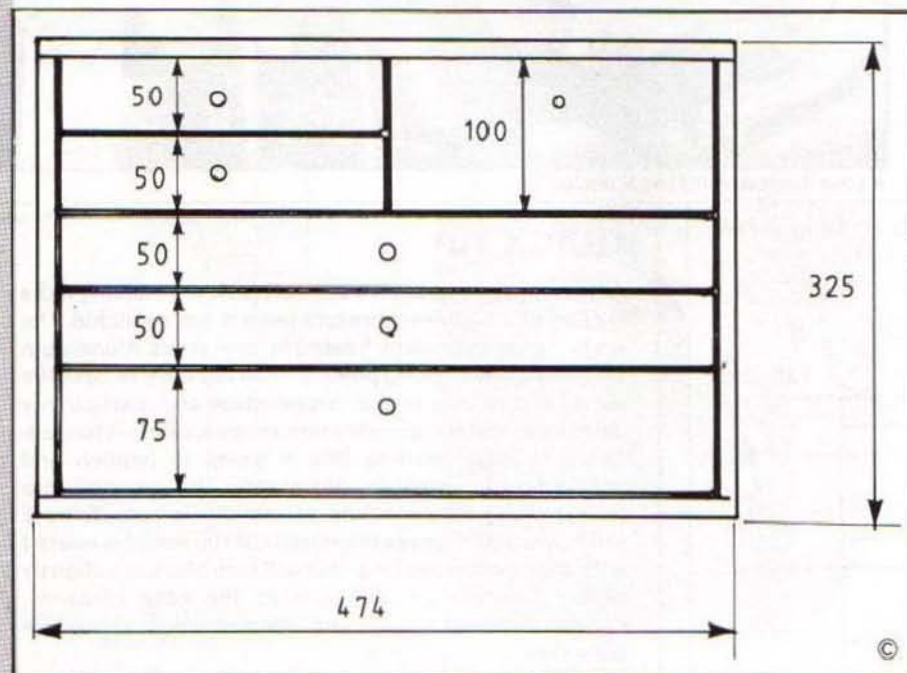
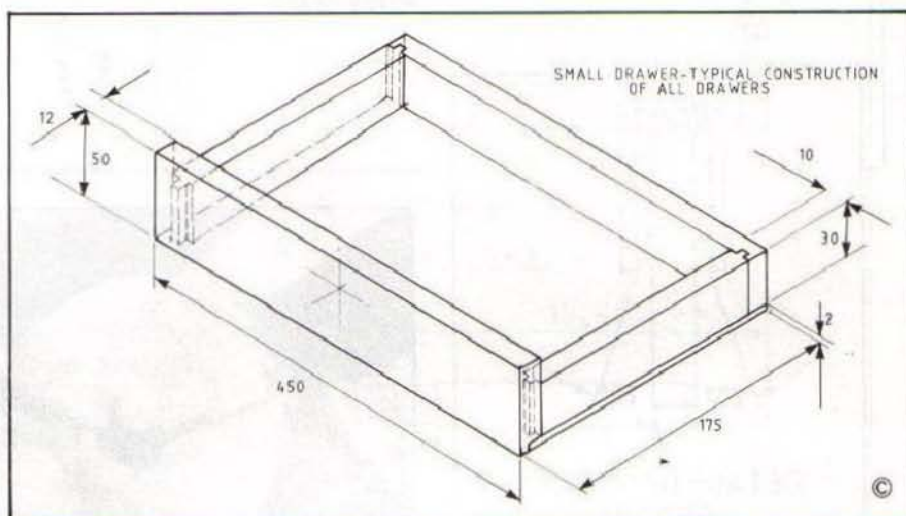
Milling the joints

This brings up a question that was raised recently on milling cutters held in lathe chucks, and the fact that they may be inclined to unwind themselves during cutting operations. This should not happen with a good quality chuck but if it does there is an easy way to cure it. Simply make up a holder from a piece of steel rod about

one inch or twenty five millimetres diameter. Drill it to the size of the cutter to be used, and cross drill and tap for as large a grub screw as possible. Grind a small flat on the cutter shank to locate with the grub screw, and then set to work. The larger diameter of the collet, as it has now become, will be gripped by the jaws without any problems at all.

Drawer bottoms

The bottom of the drawers are from thin plywood, and these are slightly recessed into the drawer front. Once again the recess can be made with a milling cutter. They can

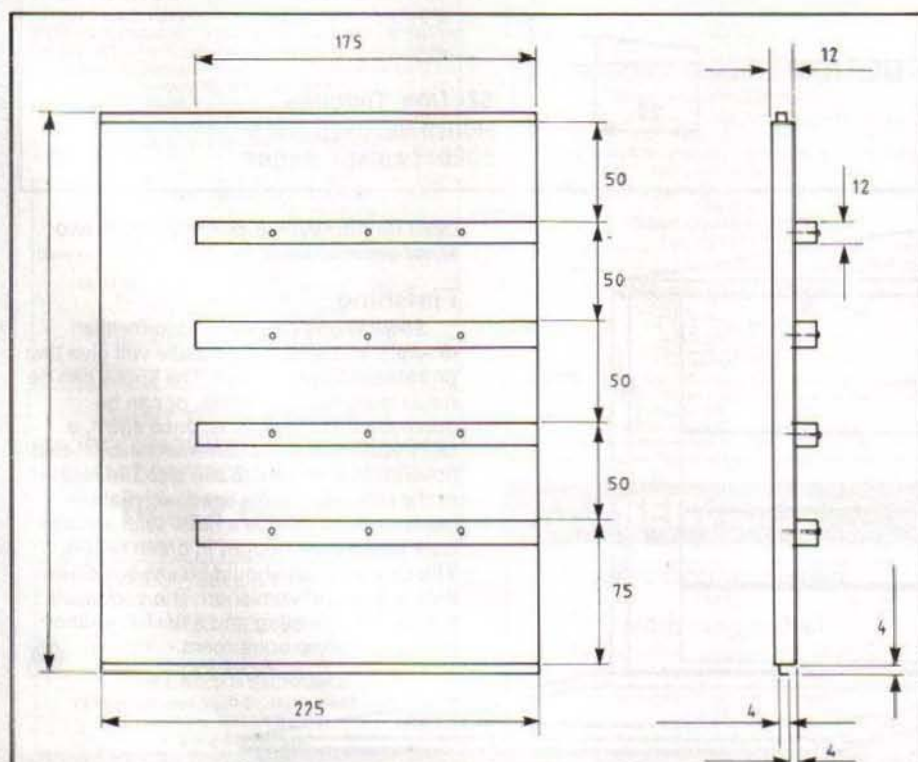
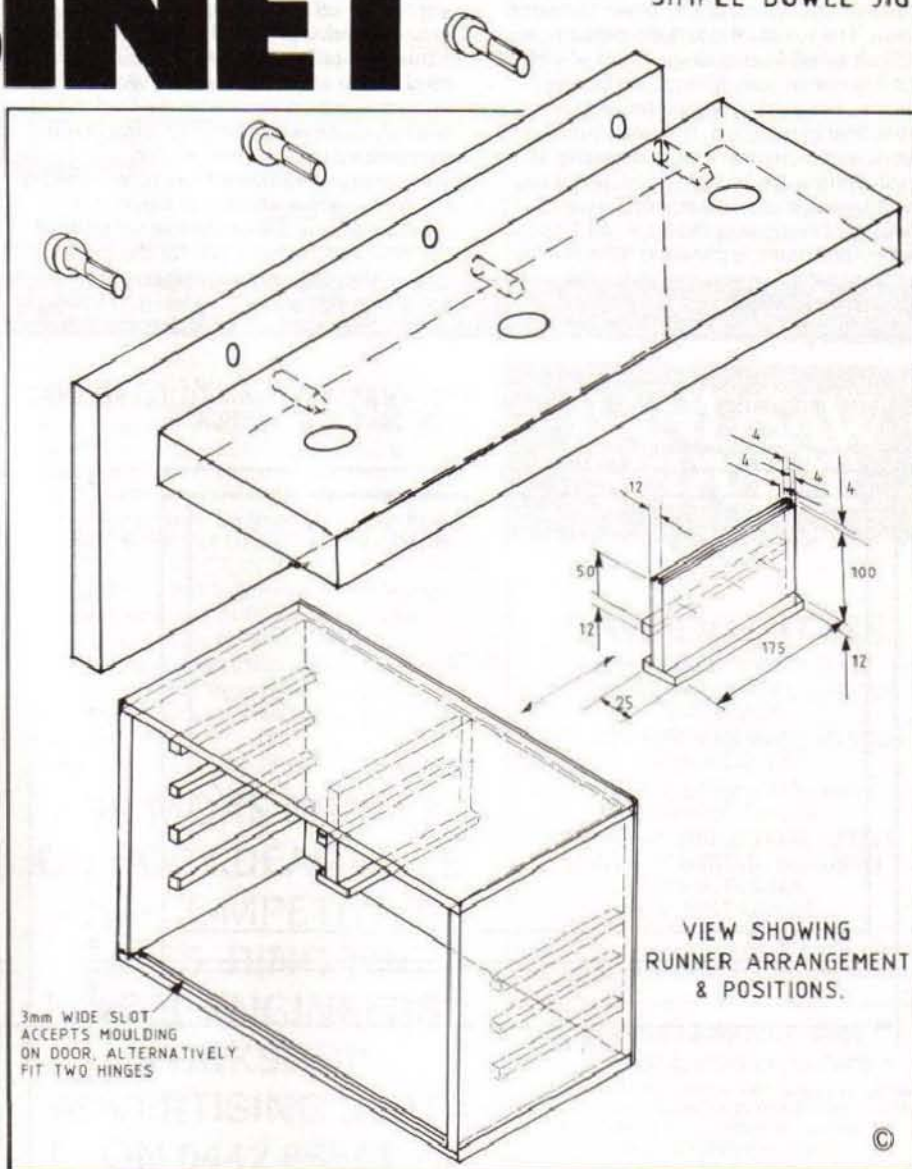


then be glued and pinned in position with $\frac{1}{2}$ in. panel pins. Of course the lathe or milling machine must be well cleaned down before using it with wood, and temporarily all oil and grease will need removing. There are several ways of doing this. Trichloroethane

TOOL CABINET
SIMPLE DOWEL JIG

Those who do not fancy milling the joints have one of two choices. The easy way is to pin and glue. Modern P.V.A. white adhesives for wood are remarkably strong and there is little danger of things coming apart, but the finished product does not look quite so good. The other alternative is to use 3mm dowelling which can be bought at any shop selling model boat and aircraft equipment.

A simple dowelling jig is easily made and will ensure that the dowels match both parts. A piece of strip steel, about half an inch wide and quarter of an inch thick, is drilled 3mm in four or five suitable places. These holes are to match the dowels so they should be placed suitably so that two dowels can be used for drawer joints, and the complete number for the sides, top, etc. Screw a piece of plate to the edge of the bar, and this then acts as a guide for the edge of the wood. A piece of bar should also be screwed across the end, to act as a guide for the centre portion, although measurement will also be required here.



PIN & GLUE RUNNER JOINTS WHICH MAY BE DISPNCED WITH & SIDES SCREWED TO TOP & BOTTOM. BACK IS PINNED & GLUED TO CABINATE. ON RIGHT HAND SIDE LEAVE OFF ONE OF THE RUNNERS AS SHOWN ON SECOND SHEET.

Use countersunk screws and either of the edge guides can then be removed as required in order to place the jig at points where the edges are not needed. With this little device, dowelling becomes very easy, but it is probably also as well to make a stop for the 3mm drill. This can be a piece of steel rod drilled 3mm with a grub screw to allow it to be secured to the drill.

These runners are again standard hardwood strip that can be bought at any do-it-yourself shop. They are pinned and glued to the sides, before the frame assembly is made up. The centre portions should also be made up at this stage. Glueing it to the top and keeping it square is not all that easy, but this should be done before assembling the frame itself. Most workshops will have an angle plate to which the parts can be clamped while the glue is setting, thus ensuring that they are nice and square.

At one time, getting hardwood for the parts would not have been difficult; now it is almost impossible. If there is a high quality cabinet-maker near you then they

may be persuaded to let you have some. Another alternative is to glue strips together and, when dry, to plane and sand down. The result, if it is done properly, is difficult to tell from a single piece of wood but it is not an easy thing to do by any means, and getting a good finish requires a great deal of patience. The final choice is to use 12mm plywood of a good quality. The finish on this can be very good, and it has the advantage of not warping. There is no method of disguising the edge, and it will be obvious that it is plywood. Whether or not this matters is something for the individual to decide.

Again, milled joints have been suggested for construction, but the same applies for other methods as with the drawers and, if plywood is used, dowelling joints may be best. The milling cutter will tend to tear at the layers of plywood. The assembly is held square by the back which is a help but even so, after glueing, it must be clamped up and checked for squareness. If hardwood has been used for the frame, a nice additional touch is to recess the back. There are two versions of the bottom: one has a slot for the door to rest in, the other allows for hinges to be used. The slot is a better idea, and milling is

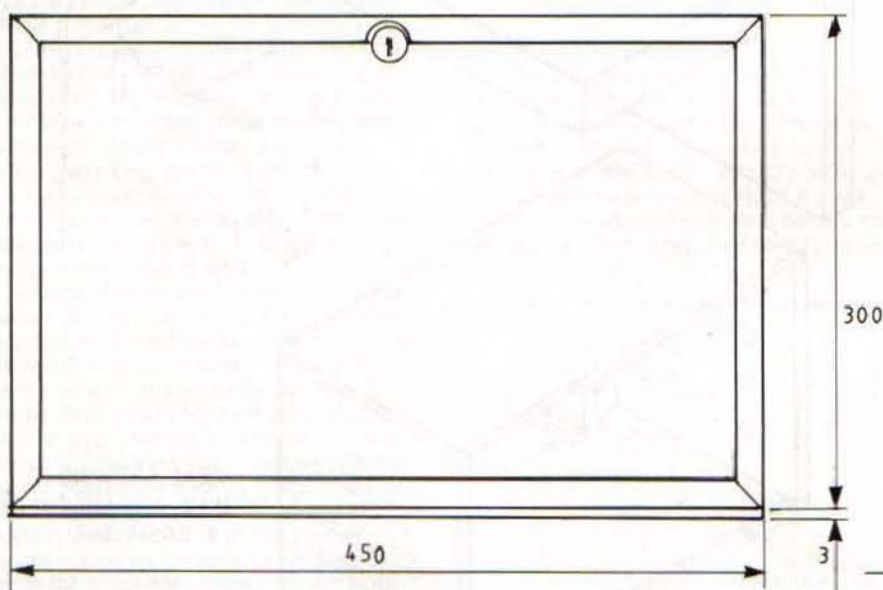
once again the answer if that is the construction chosen.

The door

It will be seen that the door is framed with flat strip wood which is mitred for appearance. This is not strictly necessary, and it may be that some readers will prefer to leave it plain. It has already been pointed out that it can be fitted in two different ways. A lock is also fitted at the top, and this of the type known as a cabinet lock, and is specially designed for this sort of work; these locks are readily available. A brass plate can be made as an escutcheon

MITRE ALL CORNERS, PIN & GLUE MOULDING TO DOOR

CUT AWAY MOULDING TO CLEAR BRASS DISK 20×2 FOR KEYPLATE

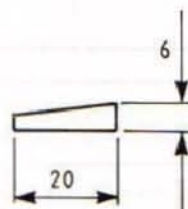


NOTE: If P.V.A. glue is used it is advisable to allow this to thoroughly dry for a few days before use.

The fumes given off as the glue cures can cause rusting on steel.

3×3 STRIP PINNED & GLUED FITS INTO SLOT IN CABINET BASE. ALTERNATIVE FIT TWO 1½" BRASS HINGES.

CABINET DOOR CONSTRUCTION DETAILS.



SECTION THROUGH MOULDING USED TO EDGE CABINET FRONT.

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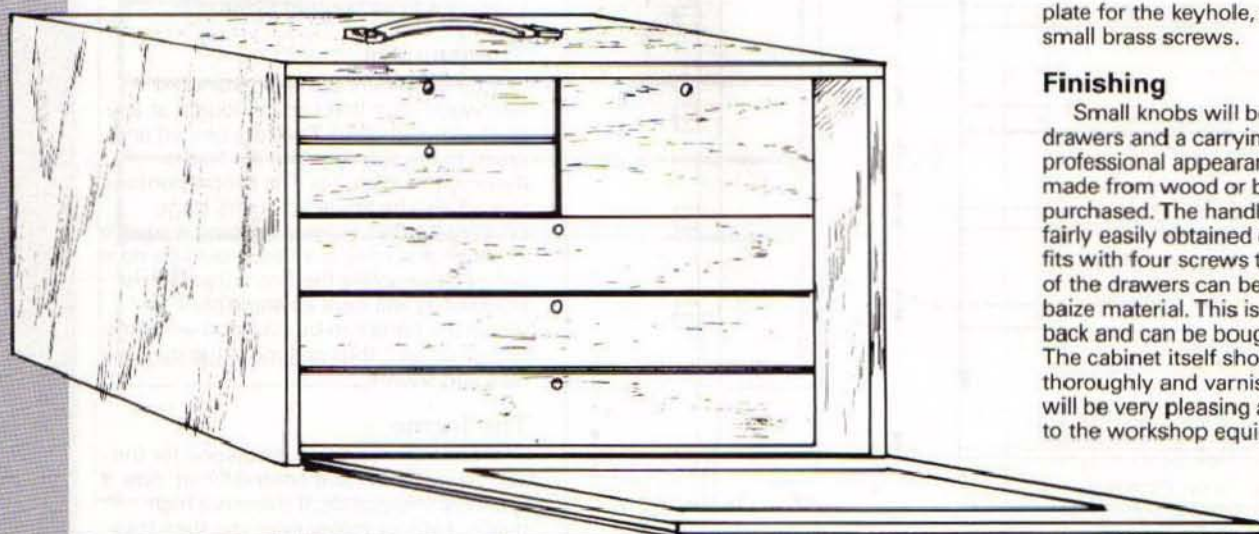


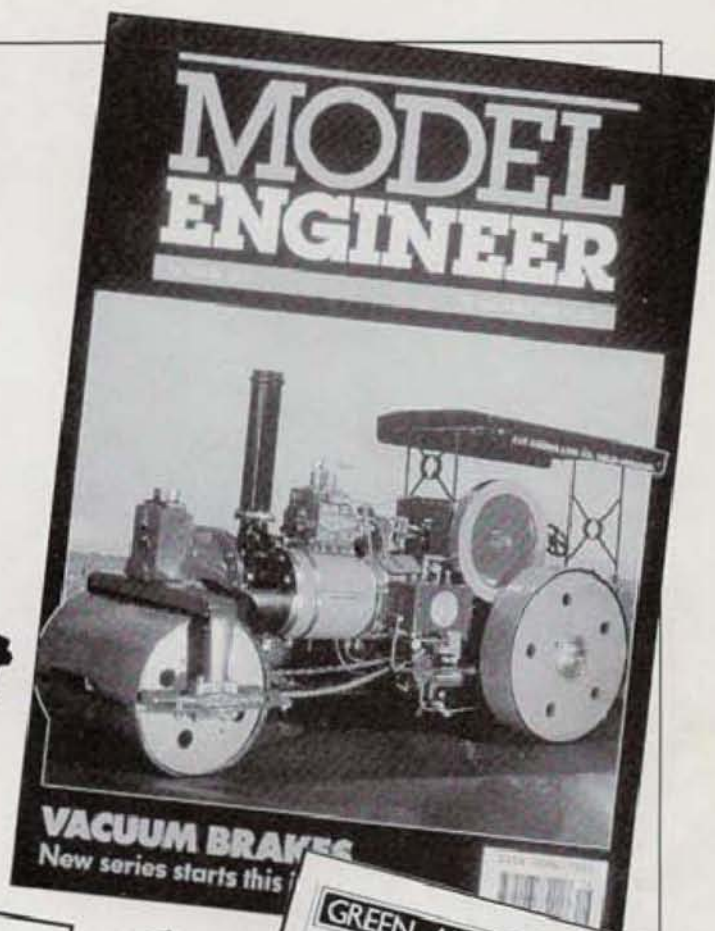
plate for the keyhole, and fitted with two small brass screws.

Finishing

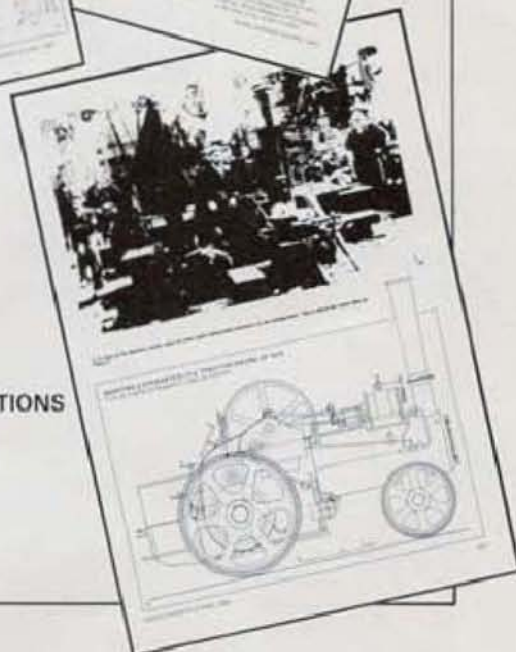
Small knobs will be needed for the drawers and a carrying handle will give that professional appearance. The knobs can be made from wood or brass, or can be purchased. The handle is, once again, a fairly easily obtained commercial item, and fits with four screws to the top. The inside of the drawers can be lined with Fablon baize material. This is a baize with a sticky back and can be bought in green or red. The cabinet itself should be sanded down thoroughly and varnished. The end result will be very pleasing and a useful addition to the workshop equipment.



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TO LOOK
FORWARD
TO...**
...every fortnight



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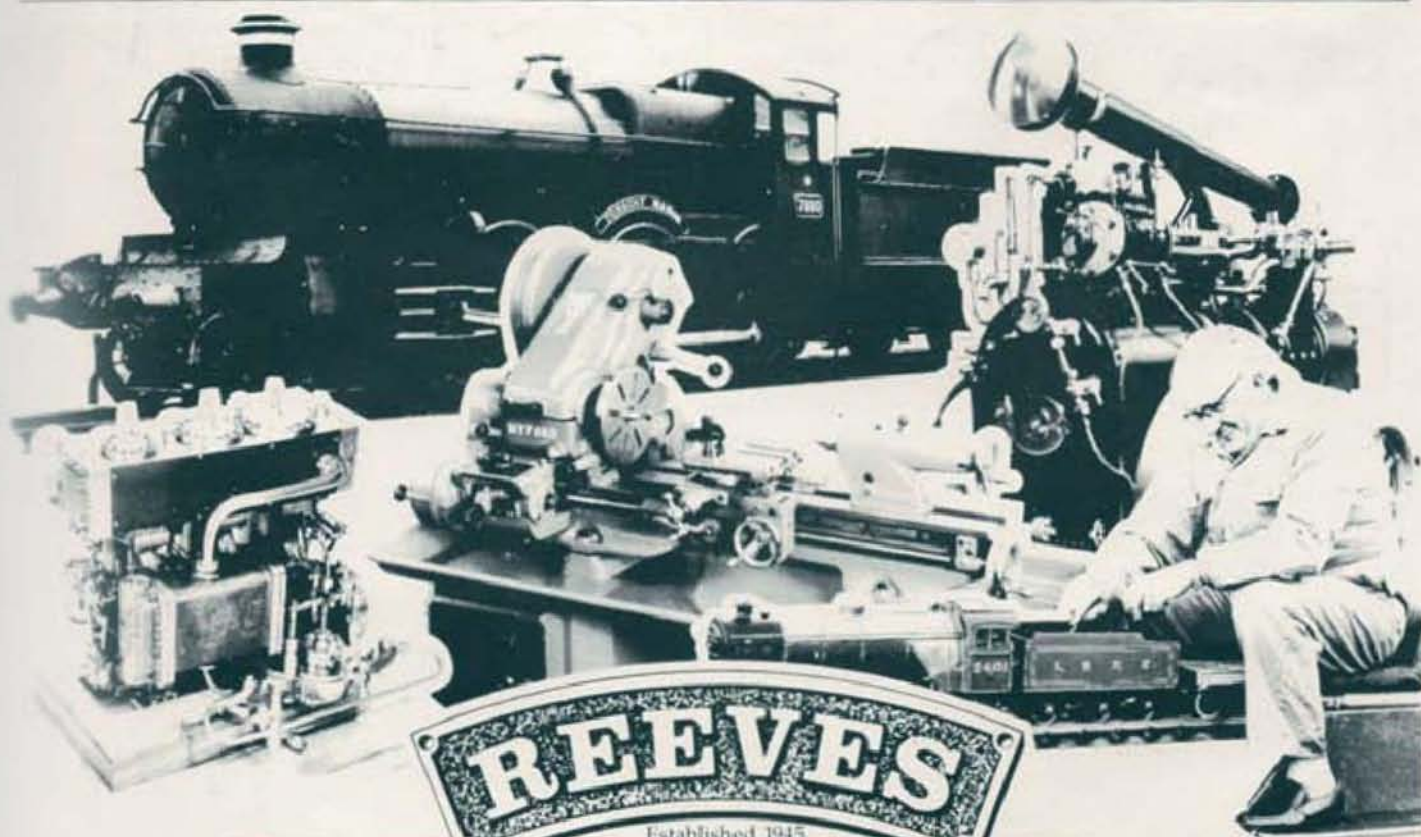
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